MEDICO-ELECTRIC APPARATUS

AND HOW TO USE IT

SALT.

A PRACTICAL DESCRIPTION

OF EVERY FORM OF

MEDICO-ELECTRIC APPARATUS

IN MODERN USE

OPINIONS OF THE MEDICAL JOURNALS ON THE FIRST EDITION

THE 'LANCET.'

"Messrs Salt and Son have a deservedly high reputation as manufacturers of surgical instruments. In the little book ('Medico-Electrical Apparatus and how to Use it') they have now issued, a description is given of every form of medico-electric apparatus in modern use, together with clear and concise directions for working the same. To practitioners devoting themselves to the attractive field of electro-therapeutics it will be found a most useful guide in the selection of instruments."

'MEDICAL TIMES.'

"The practitioner will find this the very kind of book he wants."

'BRITISH MEDICAL JOURNAL.'

"Intending purchasers of batteries will find it a good guide of shapes, prices, &c., and it is very freely illustrated."

THE 'PRACTITIONER.'

"Will be found a convenient book of reference for those who desire information as to the details of construction of many forms of batteries. It is profusely illustrated and the descriptions are clear and concise."

A PRACTICAL DESCRIPTION

OF EVERY FORM OF

MEDICO-ELECTRIC APPARATUS

IN MODERN USE

WITH PLAIN DIRECTONS FOR

MOUNTING, CHARGING, AND WORKING

SECOND EDITION

REVISED AND CORRECTED AND BROUGHT DOWN TO THE PRESENT TIME

Illustrated by carefully drawn Engravings

AND INTENDED TO SERVE AS A GUIDE TO MEDICAL MEN IN THE SELECTION OF THEIR INSTRUMENTS, AND AS A HANDY BOOK OF REFERENCE FOR ALL MECHANICAL DETAILS CONNECTED THEREWITH

BY

SALT AND SON

ANATOMICAL MECHANICIANS TO H.R.H. THE PRINCE OF WALES,

IMPORTERS AND MANUFACTURERS OF

MEDICO-ELECTRIC APPARATUS

21, BULL STREET, BIRMINGHAM

LONDON

J. & A. CHURCHILL, NEW BURLINGTON STREET

1877

Price Two Shillings and Sixpence

PREFACE

TO THE

SECOND EDITION

The rapid sale of the first edition of this little manual, and the very gratifying expressions of approval received from the medical press and the profession generally, have induced us to republish it with such additions and amendments as have been rendered necessary by the progress of medico-electric science, and the successive improvements of inventors.

No pains have been spared to render the present work as accurate and complete as possible, and we venture with respectful confidence to lay it before our readers.

21, Bull Street, Birmingham;
June, 1877.

PREFACE

The rapid strides which have been made during the last few years in the scientific application of Electricity for the relief and cure of diseases, render needless any apology for the publication of this little brochure, whose only claim to the notice of the Profession is that it lays before them in a clear and distinct form, and with the aid of accurate and carefully drawn illustrations, all the most approved of the many forms of apparatus which have been devised by physicians and others for their use.

All obsolete types, and such as lack authoritative professional recommendation, have either been discarded altogether, or passed briefly over, and a careful description of the mode of use is added for each instrument described, so as to enable a medical man to judge which form of apparatus is best suited for his special purpose; the therapeutic mode of

application must, of course, be decided for each case individually, and lies beyond our province.

The descriptions and drawings are culled from various sources by the light of personal experience, and we may specially mention the excellent works by M. Duchenne, M. A. de la Rive, Dr Tibbits' 'Manual on Electricity,' and some valuable articles on the subject by Dr Julius Althaus, which appeared in the 'British Medical Journal' in 1873, and were lately reprinted in a separate form. Of course, in a descriptive work, treating of subjects which have been previously discussed, it is impossible to avoid an occasional apparent plagiarism, and we most gratefully acknowledge all assistance derived from other authors.

The prices of the various instruments described will be found in an Appendix; nearly every one is kept constantly in stock, and can be supplied, charged and ready for instant use, at an hour's notice.

21, Bull Street, Birmingham;
December, 1874.

TABLE OF CONTENTS

PART I

GALVANIC BATTERIES

PART II

ELECTRO-MAGNETIC MACHINES

PART III

ACCESSORIES OF THE BATTERY

PART IV

GALVANO-CAUSTIC APPARATUS

APPENDIX

INDEX OF ENGRAVINGS.

A PRACTICAL DESCRIPTION

OF EVERY APPROVED FORM OF

MEDICO-ELECTRIC APPARATUS

PART I

GALVANIC BATTERIES

The apparatus employed for the generation of Electricity for medical purposes, may be divided into three classes, named respectively, Galvanic, Electro-Magnetic or Faradic, and Galvano-Caustic. To these may be added, Frictional or Statical, and Magneto-Electric batteries; these two types, however, have fallen greatly into desuetude, the former owing to their being too cumbrous for ordinary use, and somewhat dangerous unless attended with great skill and caution in their application; and the latter from the little reliance which can be placed on their physiological effects: they are, however, handy and cheap, and as they are little liable to derangement, and require no preparation for use, may be employed where Electricity is only very occasionally administered.

The Instruments will be described in the order in which they have been named above, premising that we shall avoid, as far as possible, making invidious distinctions or recommendations of any, contenting ourselves with pointing out what appear to us to be the particular advantages or drawbacks of each, and leaving our readers to form their own opinion as to their relative qualifications.

The desiderata of a good Galvanic Battery, are :—

1. That it shall furnish a stream of Electricity which shall be not only *continuous*, which is a property possessed by all batteries into whose construction a wire helix and contact breaker do not enter, but also *constant;* that is, that the current shall not be subject to fluctuations in intensity during use, nor become rapidly enfeebled through polarization, evaporation, or other causes.

2. The current must be of sufficient power, when used to its full extent, to penetrate to, and exert its influence on, the most deeply-seated nerves and muscles, and yet should be capable of being readily and promptly reduced during use, and without displacing the Battery, to a very small minimum. Provision should also be made, under the same conditions, for the reversal of the direction in which the current is guided, and for its absolute interruption.

3. The mechanism should be strong, simple, and durable, and as much as possible exposed to the view and touch of the operator, so that any little derangement can be rectified without the necessity of

returning the instrument to its manufacturer. The use of all concentrated acids or corrosive solutions should be avoided, and provision made for the removal of the elements from the action of the exciting fluid when not in use. Moreover, as time is usually a consideration of great importance to medical men, the operation of charging should present as little trouble and delay as possible.

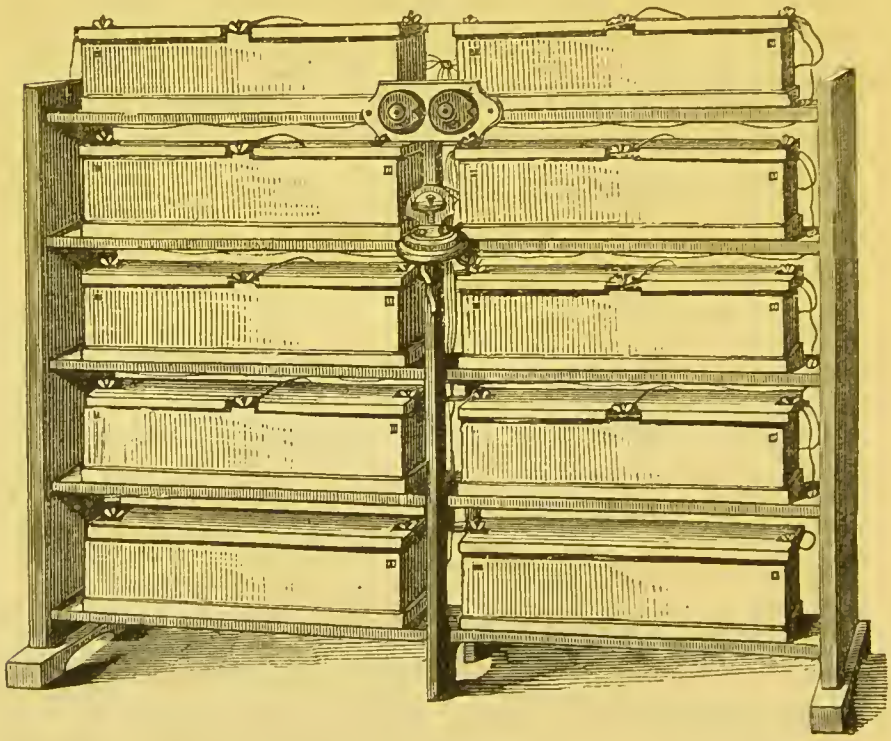
4. The Battery should not be cumbrous in size, but at the same time it must be borne in mind that Batteries composed of very small elements have a different therapeutic action to those of moderate or large size; hence very small plates should, as a rule, be avoided, as economy of space may sometimes be too much studied, to the detriment of the beneficial power of the instrument. The price need not be exorbitant, though very cheap machines are not recommended, as sufficient care cannot be exercised in their manufacture to insure satisfactory results, and to prevent the annoyance experienced when, on an attempt being made to use the instrument, it is found to be out of order and to refuse to work.

Among the many forms of Batteries which have been constructed to meet these requirements, one of those which possess the greatest *constancy* is the Becker-Muirhead arrangement, as is shown by the prevalence of its use for telegraphic purposes; it is, moreover, stated by Dr Althaus and other eminent authorities that its application is less irritating and its curative effects more decided than those of other

Batteries, owing to the electric current, of low tension, which it generates, being collected with greater regularity from a far larger surface of elements. Against these advantages, however, must be set the fact that its size renders it somewhat cumbrous, and ill adapted for removal; it is therefore most suitable for the electrical departments of public hospitals, or the consulting rooms of practitioners who freely and habitually employ electricity as a therapeutic agent.

The external appearance of the Battery is shown below (Fig. 1), and its construction and mode of use are as follows :

Fig. 1.



The elements, which are similar to those of a Daniells Battery, consist of any desired number of unamalgamated zinc, and thin copper-plates; the copper element of each pair is suspended in a porous cell containing a saturated solution of sulphate of copper placed within a larger quadrangular cell filled with water, into which dips the zinc plate from the adjoining pair.

The copper and zinc elements of each neighbouring pair are in metallic communication, and the terminal plates of each set are respectively of the two different metals ; these cells, as above described, are arranged laterally in sets of ten, and each set is fixed in a strong covered wood box.

In the most usual arrangement, ten of these cases, or 100 cells, form the Battery, and are placed one above the other, in two rows, on a convenient frame; the current is collected separately from each five cells, and guided to the back of a dial plate or plates, on which the numbers of cells are inscribed in gradations of five, and by turning which any required number may be put in action. This dial may either be attached to the front of the Battery, or fixed to the wall of the consulting room, the Battery itself being placed out of the way in a clean dry cellar or other convenient place, and connected with the graduator by insulated copper wires.

As the power of the Battery is liable to become slightly diminished through evaporation of the fluid, oxidization of the connexions and other causes, a

galvanometer is added, which is usually placed by the side of the dial, for the purpose of ascertaining whether this has taken place, and, if so, to what extent. This is effected by causing the current to pass in close proximity to a magnetic needle, freely suspended, which is thereby deflected to a greater or less extent in proportion to the quantity of electricity developed.

Dr Tibbits has found by experiment that when the Battery is in perfect action, the angle of deflection is in accordance with the following scale :

5	cells	give	45°	deflection	of the	galvanometer needle.
10	„		57°	„	„	„ „
20	„		67°	„	„	„ „
30	„		70°	„	„	„ „
50	„		71°	„	„	„ „
100	„		73°	„	„	„ „

This would be the approximate scale for all similar Batteries, but the exact angle must be determined experimentally for each individual instrument. The method of applying this scale is obvious ; for instance, should 5 cells give only 22° deflection, the Battery would be only half its normal strength, and a higher number of cells should be placed in action, where before five were sufficient. A commutator of simple form is added, to break the connexion between the Battery and the Galvanometer when the latter is not in use.

A further development of the Galvanometer has lately been introduced and its value discussed in a

correspondence in the columns of the 'British Medical Journal' and 'Lancet,' but as its use is applicable to nearly every form of Battery, a more detailed account is reserved for a separate paragraph later on.

The mode of charging the cells is exceedingly simple, and can readily be practised either by the manipulator himself, or, under his superintendence, by any person of moderate intelligence; supposing them to be new and thoroughly clean, nothing is needed but to fill the porous, or inner cells, nearly to the top with a saturated solution of sulphate of copper, and the outer ones with fresh water.

A few crystals of sulphate of copper are usually placed in the porous chambers to keep the solution in a state of saturation, which adds to the constancy of the arrangement.

The Battery will then be ready for use, and the conducting wires and appropriate rheophores can be forthwith attached to the dials.

After the Battery has been in use for a time, varying from six weeks to three months according to circumstances, the decreasing deflection of the galvanometer needle will indicate a diminution in the force of the electric current, and is a sign that the Battery requires cleansing and re-charging. To effect this, the metal plates, or elements, must be removed from the cells and the old liquid thrown away; the plates must be then carefully scrubbed and freed from all impurities, and replaced after having been rinsed in clean water; every connection

should be taken apart, and the points of metallic contact gently rubbed with emery paper until quite bright, in order to remove any oxide which may have been formed, and which would greatly impede, or altogether arrest, the transmission of the current; the cells should then be re-filled as before.

We may here remark, as a general observation applicable to every form of Battery, *that cleanliness is the very essence of success in all applications of Electricity, and the absence of it gives rise to more disappointment and annoyance than every other cause of failure put together.* If a Battery is found to be out of order and refuse to work, the reason will be, in nine cases out of ten, that some dirt has accumulated between one or other of the connexions, thus severing the continuity of the metallic contact; this should be diligently sought for, step by step, as it is astonishing how thin a film of non-conducting matter will interrupt the course of the current.

Another Battery, the action of which is exceedingly constant, is that of Leclanché as improved by M. Gaiffe, of Paris. The earlier form of this Battery consists of any number of jars, say twenty-four, standing on a square frame, which supports above it a board, on which are placed the graduator for selecting the number of cells to be used, a galvanometer for testing their state of activity, and the knobs which form the poles of the Battery, and to which the conducting wires are attached. The pairs, or cells, which communicate,

inter se, by metallic connections, consist of a rod each of zinc and gas-carbon passing through the mouths of the before-mentioned jars, the remainder of which are filled up with powdered gas-carbon and native peroxide of manganese, saturated with a concentrated solution of chloride of ammonium; a cap made of vulcanite or other suitable material closes the vessel, and through it pass the zinc and carbon elements; it also has apertures to admit of the escape of the hydrogen and ammonia formed during the action of the Battery. Various forms of collector for this apparatus have been contrived, notably one by M. Tripier, by means of which the intermediate or terminal cells may be put in action independently of the initial ones, thus distributing the strain of the electric action over the entire Battery, instead of confining it, as is usual, when a part only is employed, to the first few cells.

This instrument is not as yet widely known or extensively used in England; possibly because its charging and cleaning can scarcely be accomplished by any one but the maker; moreover, though, owing to its great constancy, it is well fitted for occasional work, spread over a long period, yet, as it is very subject to polarization, it does not serve so well for continuous work; after a while, too, fumes of ammonia are given off, owing to the decomposition of the chloride of ammonium with which the cells are charged, and which is very objectionable.

A portable Battery on the same principle of very

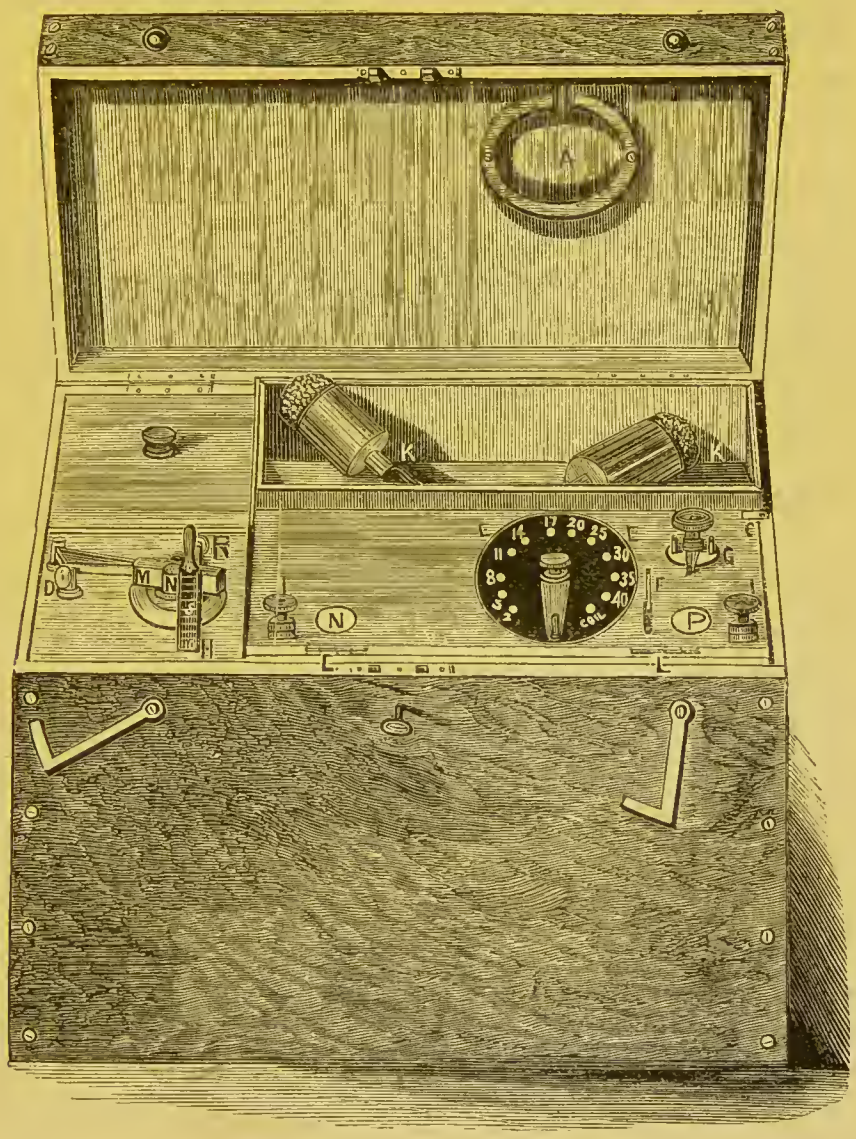
simple form has been constructed by Professor Beetz of Munich. In this instrument a vessel of cylindrical form is partly filled with powdered charcoal, and partly with a concentrated solution of chloride of ammonium; a zinc rod, sliding through a vulcanite cover, passes through the chloride into the carbon, its free extremity serving as one pole of the cell, while a platinum wire passing through the bottom of the glass into the carbon acts as the other. A number of such cells, suitably combined, and with arrangements for graduation, form the Battery,

At the instigation of Dr Herbert Tibbits Mr Hawksley has constructed a Constant Current Battery for which are claimed the undoubted advantages of being always (until exhausted) in action and ready for immediate use, and of having its elements and exciting medium so nearly in a dry state that all risk of accident from an overturn is avoided.

It is constructed of any number from twenty to a hundred of small cells on the Leclanché principle. The elements consist of a zinc plate inserted in sal-ammoniac and a carbon plate inserted in powdered peroxide of manganese in a porous cell. The maker says, "Before leaving the workshop a sufficient quantity of water should be carefully added by means of a syringe to each cell to moisten the contained chemicals. This is a delicate and tedious operation, and it is very important that no water be allowed to run over between the cells. The water should be carefully divided between the two parts

of each cell, and as some time is occupied in saturating the ingredients several injections may have to be made. There are practical advantages also in

Fig. 2.



the cells being securely packed away from risk of accidental damage, but if desired the batteries can

be so constructed that the purchaser may himself add the water and a measure and syringe can be supplied, *but this cannot be recommended.*"

The Battery is provided with a commutator and selecting dial, and is in every respect well and substantially made. Its only drawback for country practitioners is, that when exhausted it cannot be repaired or recharged except by the maker.

An induction coil with suitable arrangement is sometimes placed at the side.

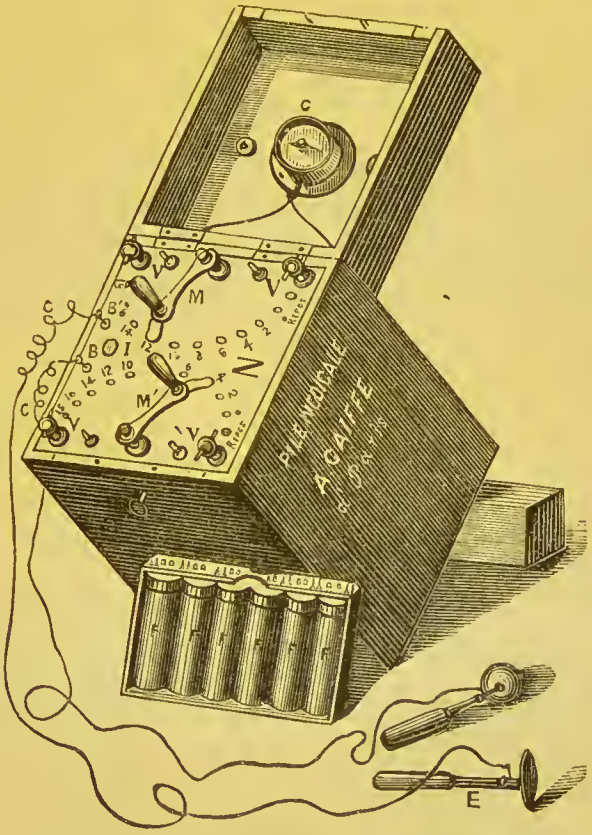
A Battery similar in principle, but somewhat differently arranged, has been designed by the Telegraph Works Company, and another by Messrs Mottershead, of Manchester, for each of which some special advantages are claimed by the makers.

Passing on from the forms of which Leclanché's instrument is the type, we come to those wherein one of the elements is chloride of silver; these are principally manufactured by Gaiffe, and Dr Stöhrer of Dresden. The former of these gentlemen has constructed two Batteries on this principle, one being very portable and cheap, and the other larger, and more generally useful. The first of the two takes the form of a small octavo volume, and contains from twenty-four to sixty pairs, consisting of a zinc rod, which together with a silver cup suspended by a silver wire, and containing chloride of silver, is immersed in diluted sulphuric acid or a solution of table salt.

The larger form of the same Battery (Fig. 3) is

contained in a wooden case, and possesses two graduating handles, M M′, for the selection of the required number of cells; a galvanometer, C; a pedal, G, for interrupting the current or giving shocks; and two clamps for the attachment of the conducting

FIG. 3.



wires. This battery is said to be handy, compact, and serviceable, and to be capable of working 800 hours without intermission.

Dr Stöhrer's Chloride of Silver Battery is constructed on the same principle as the two last described, and comprises forty, fifty, or sixty pairs,

with a lifting arrangement whereby they can be brought into, or taken out of action.

The pairs consist of cylindrical glass tubes six inches high, on the bottom of each of which is placed a small quantity of chloride of silver, which, when the glass is raised, comes in contact with a small strip of silver. In the upper portion of the tube, three inches from the chloride of silver, a cross of zinc is placed, and the cells are charged with diluted sulphuric acid in the proportion of one in ten.

It is necessary to close the circuit of this Battery for from five to ten minutes to allow of the decomposition of some chloride of silver, without which it would not act; on the other hand, when all the chloride is decomposed, which becomes evident by the appearance of bubbles of hydrogen, more must be added at once, or the action (for that cell) would cease, and the Battery be weakened *pro tanto*. Dr Althaus says this phenomenon does not always occur simultaneously with all the pairs, but generally first in one and then in another, and must be watched for, and remedied immediately, wherever it appears, by adding fresh chloride of silver. This forms a very serious objection to the use of the Battery.

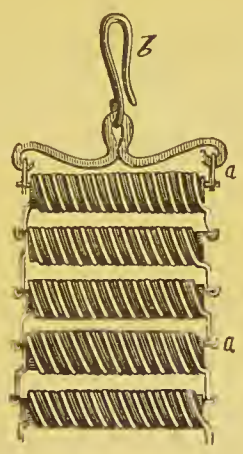
We will sum up our ideas of this class of instrument in the words of the above-named authority. "The Chloride of Silver Battery may, on the whole, be said to be still on its trial; we have no intimate practical acquaintance extending over a long space of time, with any of the arrangements described above.

A drawback to Gaiffe's old Chloride of Silver Battery was that it began to leak after having been in use some time, but this has now been obviated by employing a much smaller quantity of liquid than formerly."

Among other forms of constant current Batteries which the practitioner may occasionally employ, are Pulvermacher's Chain Bands, and Flexible Batteries; these are intended either to be worn upon the body in certain nervous and kindred diseases, or to be used in the ordinary way, either as continuous, or interrupted current Batteries. A general idea of their appearance may be obtained from the diagrams, Figs. 4, 5. Fig. 4 is a flexible chain, or band, composed of alternate pieces of zinc and brass wire,

Fig. 4.

Fig. 5.



suitably connected, but prevented from being in actual contact by cotton threads laid between them;

they are made of different lengths and terminate at each end with a plate bearing a wire loop whereby they can be attached to each other in combination if necessary. The plate coloured white is connected with the zinc, and that coloured yellow with the brass pole, and tapes are provided to facilitate the fixing them on the body. They are set in action by being passed two or three times from end to end through a mixture of vinegar and water in the proportion of one in six; this should be repeated at intervals, the moisture and acidity of the skin continuing the galvanic action meanwhile.

Fig. 5 represents a more powerful Battery in which the elements are formed of cylinders of brass containing within them smaller cylinders of zinc; this form is intended to be used by means of electrodes and sponge-holders, or, with the aid of an ingeniously arranged little "trembler," as an interrupted current Battery.

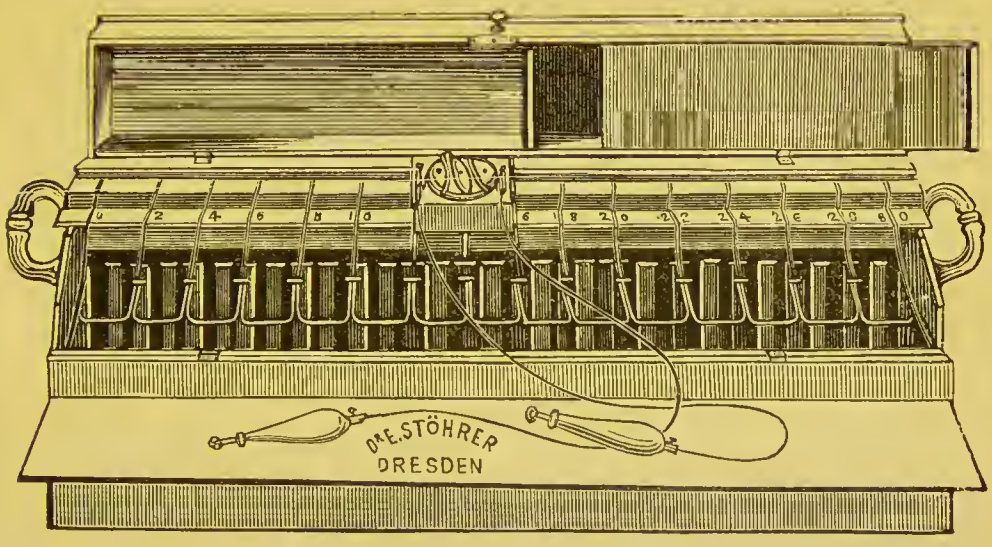
We now come to the series of Batteries most widely known and generally employed, and will commence with those invented and manufactured by Dr E. Stöhrer, of Dresden, as they were the models whence most of the constant current Batteries now in common use originated.

This inventor, besides the Chloride of Silver Battery already described, has introduced two forms of instrument—the one being intended for hospital, the other for private practice. The principle in both is identical, and the construction only differs

so much as is necessary to fit them for their respective uses.

The Hospital Battery (Fig. 6) is contained in a stout oak case, folding to the top so as to expose its contents, and having an iron handle at each end; the lower part of this case contains two wooden trays, one occupying each longitudinal half of the box, and

Fig. 6.



both resting on a flat shelf with wings like a book tray. This shelf can be raised or lowered by means of two ebony handles, which project from the ends of the box, and which, when they have attained a certain elevation, may be turned a quarter of a circle either to the left or right, when they will prevent the shelf from again descending until the action is reversed and it is intentionally lowered; each tray supports fifteen or twenty quadrangular glass cells, according to the size and strength of the Battery.

Along the top of the case, from end to end in the centre, is placed a wooden bar, called the plate-carrier, deeply grooved superiorly, to which are attached the elements so as to dip into the before-mentioned glass cells, when the latter are raised; the bar is pierced with as many notches, half on each side, as there are cells, and in the front of each notch a hole is drilled: on the extreme left-hand side there is only one hole, which is in the centre, between the two notches. The elements consist of carbon and amalgamated zinc plates, and are suspended from the plate-carrier by means of copper wires passing through the notches and fitting into the holes referred to, bent downwards in an arch, and furnished at the lower extremity with a boss transfixed with a screw; on these screws the plates are fixed, the zincs on the left, the carbons on the right, and screwed home by nuts; the hole in the centre at the left hand is occupied by a copper arch, carrying a carbon plate on the nearer, and a zinc plate on the further arm. On the right-hand side of the Battery the copper wires carry respectively a carbon and a zinc plate only. The whole is so arranged that each wire serves as the connexion between two cells, its carbon dipping into one and its zinc into the other; the plate-carrier is numbered progressively from left to right with the number of the cells by twos.

For the purpose of collecting the electricity generated by the Battery, and selecting the number of

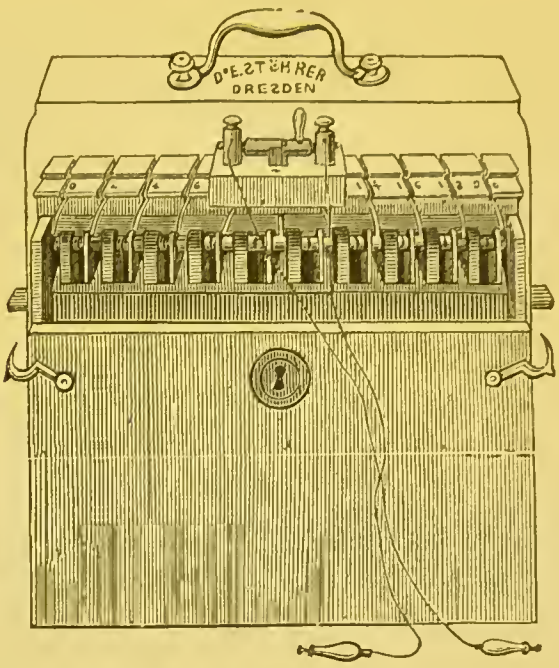
cells appropriate for each case, a wooden block or sledge is made to slide tightly along the plate-carrier, its under surface being in metallic connexion with the copper wires supporting the elements. On the top of this block are the clamps for receiving the conducting wires, and an ingenious commutator for reversing or cutting off the current: if this commutator be turned so as to be perpendicular to the user, the current is cut off; if to the right, the right-hand stud is negative and the left positive, and the contrary if turned to the left; the centre of the slide indicates the number of cells employed, and the electrodes, sponge-holders, and carbon rheophores are contained in a small drawer in the lid of the case.

This Battery is made in three sizes, containing respectively twelve, thirty, and forty cells.

Stöhrer's portable constant current Batteries (Fig. 7) differ, as has been stated, in no material point from those last described: the cases are made of mahogany, and are much smaller, lighter, and neater; the cells are of vulcanite instead of glass, and those of each side are moulded in one piece instead of each being separate; they are raised and lowered in a precisely similar manner. The commutator on the sledge is rather differently constructed, being composed of a cylinder rotated by a lever instead of a revolving disc, but its mode of action is identical, the current being cut off when the handle is upright, and the right-hand pole negative when it

is turned forwards or towards the spectator, and positive when it is turned backwards or away from him. These Batteries are made of two sizes, fur-

Fig. 7.



nished respectively with twenty and thirty cells each.

The construction of these instruments having been thus carefully described, it remains to explain the method of mounting and charging them, premising that the same remarks apply to both forms.

As they are imported from Dresden, they cannot be sent fitted up ready for use, but are taken to pieces and carefully packed. On their arrival it will be found that the carbons have been removed from the copper wires, and packed two by two in the

cells; the nuts which held them are partially screwed on again, and the zincs, still attached to the wires, placed in the unoccupied cells.

First, remove the whole of the plates, wires, &c., from the case, and empty away any straw or rubbish which may lie therein; then select the arch for the left-hand side, fix to it a carbon and zinc by means of the little wrench which will be found in the lid, and push the centre peg as far as it will go into the central hole of the plate-carrier. Then take any one of the zinc plates with nut attached, and screw on to it a carbon plate, placing the end of the wire into the next hole to the right of the one already occupied, so that the zinc dips into the first cell and the carbon into the second. Proceed in this manner until you come to the last cell on the right-hand side, which must terminate with zinc, for which purpose you will find a wire with single screw. Going now to the other side, the plate opposite the single zinc must be a single carbon similarly fixed; the intervening spaces to be filled up as before. All the wires must be carefully pushed down between the notches, so as to allow the sledge to slide freely between them, and care must be taken in handling the carbons, as they are rather brittle. It will be found better to raise the tray of cells during the process of mounting, that the position of the plates relatively to them may be more easily seen.

The Battery is now ready for the reception of the exciting fluid, which is diluted sulphuric acid in the

proportion of one to twenty, or a little stronger; this should be poured through a small porcelain funnel into each cell until it is filled to within half an inch of the top. A small pinch of bisulphate of mercury is put into each cell, and the selector or sledge placed so that its CENTRE rests immediately over one of the copper wires; this is very important. The electrodes and rheophores are attached, and the circuit completed, when if all has been properly done, the hissing sound attendant on voltaic action will immediately be heard. When carbon poles are used, and very closely approximated, the electric light should be brilliantly visible.

Should the hissing noise be heard without completion of the circuit, it is clear evidence that some, or all, of the plates wants re-amalgamating. When out of use the tray must be lowered so as remove the acid from contact with the plates; the cells will then be not more than one-third full, and with moderate care the contents can hardly be spilled; but if a little should be upset, it can be removed by taking out a small wooden plug at the bottom of the left-hand side of the case, which should be slightly inclined so as to allow the overflow to run out. Care must be taken that no metal vessels are employed for the reception of the acid.

The Battery, when thus charged, should last without further care or attention from two to three months; if, however, through constant use or evaporation of the fluid the action has become weakened

meanwhile, a teaspoonful of concentrated sulphuric acid and a little water may be added to each cell to supply the loss. When this "nursing," as it is called, fails to restore the Battery to its original activity, it must be dismounted and recharged, the carbons and connexions thoroughly cleaned, and the zinc plates re-amalgamated. The copper wires should be cleaned with sand-paper at their points of junction, and the carbons gently scrubbed in warm water with an old nail-brush.

The mode of amalgamating the zinc plates is as follows:—After being separated from the wires, they should be dipped for a minute or two in tolerably strong sulphuric acid (one in four) and held over a saucer while a small quantity of quicksilver is poured over them, and rubbed in with a hare's-foot, or bit of washleather tied on a stick until it adheres, and an uniform bright surface is obtained; each plate should then be plunged again into the acid to see if any bubbles arise, which is a proof that some part of the surface is left unprotected, and the process must be repeated until they cease to appear; the whole of the parts should then be left to dry for twelve hours, and screwed together in the same order as before.

Without wishing to transgress the rule as to recommendation laid down in the preface, we may say that the Batteries made by Dr Stöhrer after the foregoing patterns are always satisfactory, and being very simple in their mechanical construction, are

little liable to get out of order, and require a very small amount of manual dexterity in their preparation and use.

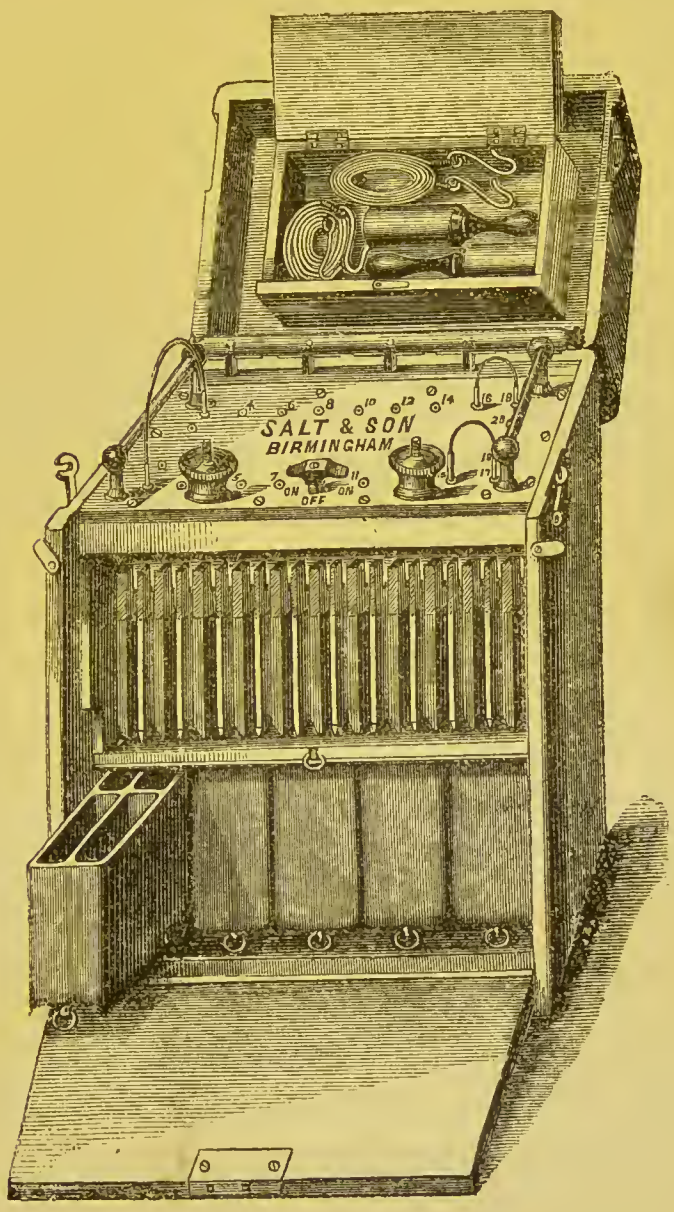
Two sources of trouble and inconvenience observable in this Battery we have endeavoured, at no small pains and cost, to remedy in an instrument of our own design. The first is the necessity of removing all the plates before the cells can be emptied of exhausted acid; the second, the destructive effects which might be produced if the Battery were accidentally capsized and the fluid spilled.

The instrument referred to is illustrated by Fig. 8, which gives a very clear representation of its appearance and construction. The Battery is enclosed in a handsome mahogany oblong case, with flat top, and its entire front is hinged, so as to fall forward, as shown in the drawing; the elements, which are the same as those used by Stöhrer, are suspended from an ebonised element board, which fits easily on a rabbit at the upper part of the case, and may be removed therefrom by a brass handle fixed at either end.

The cells (in the specimen before us twenty in number) are made of vulcanite in sets of four, and slide by five clips on to five horizontal plates attached to as many vertical rods with cross handles, by means of which any number, in gradations of four, may be drawn up for use, and are then prevented from gravitating downwards

by springs attached to the vertical rods. When it is desired to lower the cells, a slight pressure of

Fig. 8.



the thumb on the springs will permit them to descend by their own weight; they may be drawn

out through the open front of the case for emptying and refilling.

To prevent accidental spilling of the acid a wooden board, faced with india rubber to resist its action, slides into a groove between the bottom of the plates (without touching these) and the tops of the cells, and the latter are pressed against it by springs attached to the bottom of the case. The springs are controlled and the cells depressed for the introduction of this board by a brass tube seen resting on the tops of the five vertical rods.

On the surface of the elemental board are twenty brass sockets, one in connection with each cell of the Battery below, two screws for the reception of the conducting cords, and a commutator for reversing or arresting the course of the current.

The brass sockets referred to are numbered, and connection is made between any desired number of them by means of an insulated wire having a peg at each end; any of the cells may thus be drawn up and isolated so as to avoid undue use of the initial ones.

Should one of the carbon plates be broken, and the connection thereby destroyed, a second, shorter insulated wire is supplied, which, fixed laterally in the sockets of the two adjoining pairs, bridges over the broken one, and serves to convey the current, which is only weakened by the loss of the defective cell.

The commutator is a vulcanite button, so marked as to clearly show when the current is on, and

which is, at the time, the positive or negative pole, the poles being reversed by a half revolution; the conducting wires, rheophores, and a small vulcanite measure, holding the exact quantity of acid required for each cell, are contained in a small case in the lid. The acid employed is the same as that used for Stöhrer's Batteries.

To remove any of the plates for cleansing or amalgamation, lift out the element board and place it inverted on the same rabbit which before supported it upright; the elements may be drawn from their seats by screwing a small instrument (found in the lid) into a tapped hole visible in front of each pair, and pulling it towards you; the pairs may then be easily separated.

This Battery has met with great approval from every medical man to whom we have submitted it, and we venture to hope will supply a recognised want.

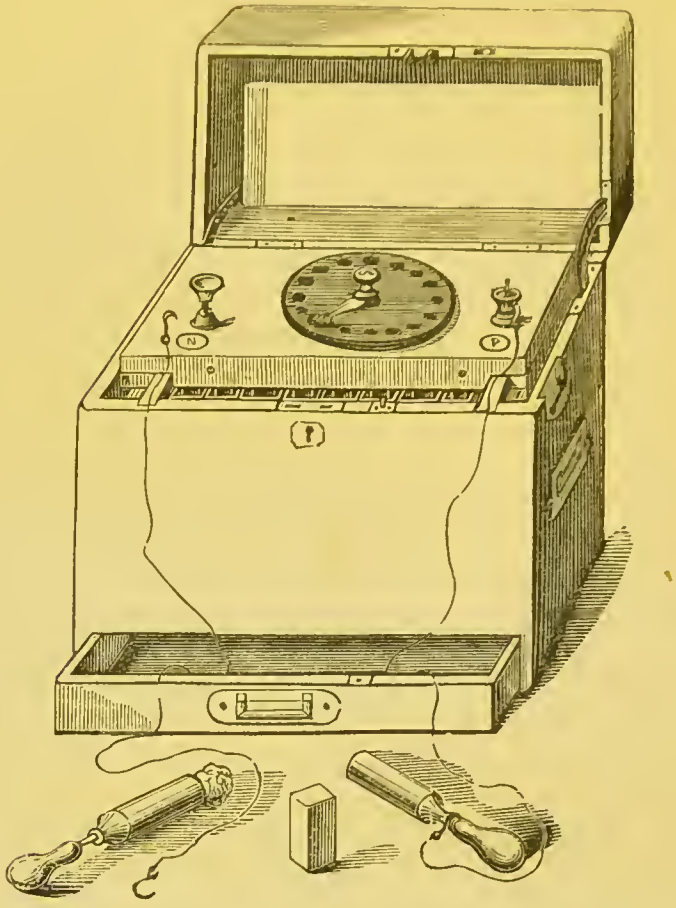
A serviceable and convenient form of portable constant current Battery is that designed by Mr Foveaux, of the firm of Weiss and Sons, drawings of which are given below (Figs. 9, 10, 11).

Fig. 9 illustrates the Battery complete and ready for action, with the conducting wires and sponge-holders attached. Figs. 10 and 11 represent respectively the element board and plates, and the tray containing the cells, or receptacles for the exciting fluid.

The Battery before us is on Smee's principle,

and consists of fifty pairs of zinc and platinized

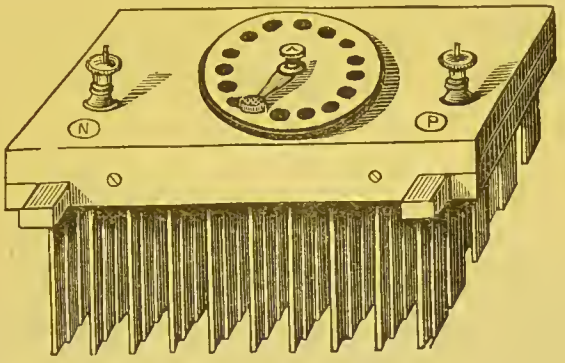
Fig. 9.



silver plates attached to an element board (Fig. 10), on the top of which are the clamps for receiving the conducting wires, and a dial plate with twenty-five divisions, round which traverses an arm with index for regulating the number of cells to be put in use; the divisions are numbered consecutively from two to fifty, advancing by graduations of two, so that the power can be very delicately regulated.

Concealed in the thickness of the element board are the connecting wires which collect the electricity

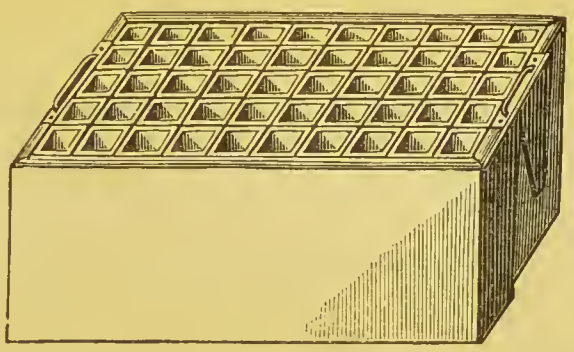
Fig. 10.



developed in the individual cells, and accumulate it beneath the dial plate.

The cells (Fig. 11) are of porcelain, and are packed

Fig. 11.



in a box, as shown in the drawing, so as to exactly coincide in vertical position with the plates suspended to the element board, beneath which they are placed on a tray supported by a system of levers in connexion with the lid of the box, so ingeniously contrived that when the lid is opened

and thrown back, the cells with their contents are elevated into contact with the plates, and the Battery is thus put in action, whereas, on closing the lid, they are immediately lowered into their former position, out of contact, and all action ceases: so that the almost instinctive action of closing the case after use prevents unnecessary waste both of acid and zinc. Beneath the small jars is placed a lead tray, which, being very slowly acted upon by dilute sulphuric acid, tends to a very great extent to preserve the case. A drawer at the bottom of the box contains the conducting-wires, sponge-holders, and a small vulcanite measure holding the exact quantity of acid required for charging each cell. The Battery is nicely finished and portable, being only fourteen inches long, seven and a half inches wide, and ten and a quarter inches deep; these measurements refer to the instrument we have been describing, which contains fifty cells, but smaller ones are made, of exactly similar construction, having respectively twenty, twenty-five, and thirty pairs of elements each.

To charge this apparatus the element board and elements (Fig. 10) should be lifted bodily out, and laid on the table bottom upwards, so as to avoid injuring the zinc or silver plates; the tray of cells should then be lifted out by means of a brass ring, which will be found at each side; each cell is then to receive one vulcanite measureful of diluted sulphuric

acid (one in twenty or thirty) and the whole replaced as before, when the Battery will be ready for action.

Dr Althaus says that some inconvenience is experienced in the use of this Battery, owing to polarization, which materially diminishes its activity, even, when not freshly charged, during the course of a single application of electricity. As a remedy he suggests that the lid should be closed and immediately reopened once or twice, a process which, by the rapid emersion and immersion of the plates, mechanically wipes off the bubbles of hydrogen which polarize the platinum, and restores the instrument to its former energy. Failing success in this manœuvre, or if the invariable hissing noise is not heard on closing the circuit, the cells must be refreshed with a little concentrated sulphuric acid, as was recommended for Stöhrer's Battery under similar circumstances, or, as the case may be, emptied and altogether recharged.

Occasionally, after long or frequent use, the zinc plates become foul, and require cleansing and re-amalgamation, which would be evidenced by hissing or bubbling in one or more of the cells when the circuit is *not* closed. To effect this, the element board is removed from the Battery, and its cover unscrewed, when the connexions between the plates *inter se*, and with the dial, and the couplings between the two metals of each pair will become visible; these must all be unscrewed, and the zinc pairs

carefully cleansed from any accumulated sulphates with a stiff brush dipped in diluted sulphuric acid, and well re-amalgamated in the usual manner, dried, and replaced in exactly their former order; the platinized silver plates will require no attention, and must be preserved from contact with the mercury.

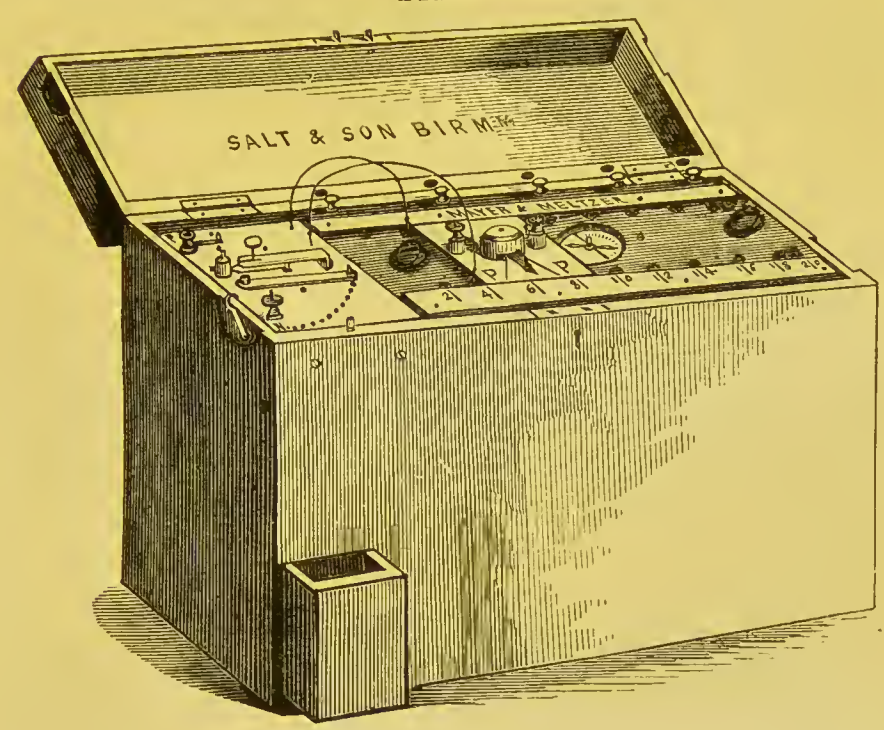
These directions may be followed without much difficulty by any one possessed of a moderate degree of mechanical skill, but unless the distance is very great, or some insuperable obstacle stands in the way, we should strongly recommend that the Battery be sent to the house from which it was obtained to be re-amalgamated, as a very slight mistake in putting together would derange its action. With care, however, it is a most efficient and reliable instrument, capable of standing any amount of hard work, and very little liable to get out of order.

Messrs Mayer and Meltzer have constructed a very ingenious Galvanic Battery which, in addition to the apparatus heretofore described, is provided with a well-made primary and secondary induction coil, with current-breaker, &c., the description of which, however, will come most properly under the head of Induction Machines.

The constant current Battery of this apparatus (Fig. 12) consists of twenty pairs of carbon and amalgamated zinc elements suspended from an element board, on which a vulcanite sledge, or selector, is made to traverse, whose under side is in metallic communication with wires passing through

the element board and connected with the plates, whilst its upper surface bears upon it a commutator

Fig. 12.



or reverser of the current, and the clamps for carrying the conducting-wires; a galvanometer is added for ascertaining the condition of the Battery, and two folding handles whereby the element board, with plates attached, can be lifted bodily out of the case.

The cells are made of vulcanite, in sets of four, and, when not in use, remain out of contact with the plates at the bottom of the case, whence they can be raised, four at a time, by means of five brass rods working in the woodwork at the back of the

case so tightly, that they cannot descend unless purposely pushed down. By a recent improvement the whole number may be raised *en masse* out of the case if desired, for cleansing or other purposes. The induction apparatus is situated to the left of the Battery, and a drawer underneath it contains the conducting wires and rheophores, and a measure holding the exact quantity of acid required to fill each cell.

This instrument, as now produced, is greatly altered from its original form, being vastly improved and simplified. It is also made, as a constant current Battery only, by the omission of the Faradic apparatus; the accessories are then contained in a drawer in the lid of the case.

The Battery is charged with diluted sulphuric acid in the proportion of one in twenty, and the process is effected in the following manner. Lift out the element board and elements by means of the two looped handles, which will be found one at each end, and draw up the cells by the brass rods at the back; in each place one measureful of the acid, and a pinch of bisulphate of mercury, and carefully replace the cover as before.

To set the continuous current Battery in action, affix the conducting cords to the clamps on the sledge, and turn the commutator handle to P, the bridge standing at 4; then draw up the first set of cells by the wire marked 4, whereby four cells are brought into action; if eight or more are required,

draw up No. 8 as well, and push the bridge along to correspond with 8, and so on up to 20, if all are required in action.

To set the Induction Battery in action, insert the two small cords one in each hole in the cover, and the other ends in holes in the flat brasswork of the element board; draw up four cells as before, and the Battery will be in action. A more exact description of the mode of using Faradic Batteries will be found further on; suffice it now to say that provision is made for a primary and secondary current, with a commutator for the selection of either, and a graduating lever is added for modifying the intensity of the shocks.

With this Battery, as with Weiss's, if the zinc plates require re-amalgamating, it is desirable to send it to the maker or agent, by whom it can be speedily and effectually done; but should the user determine upon attempting it himself, the following is the method of separating the plates: the actual process of amalgamation is of course the same as has been previously described.

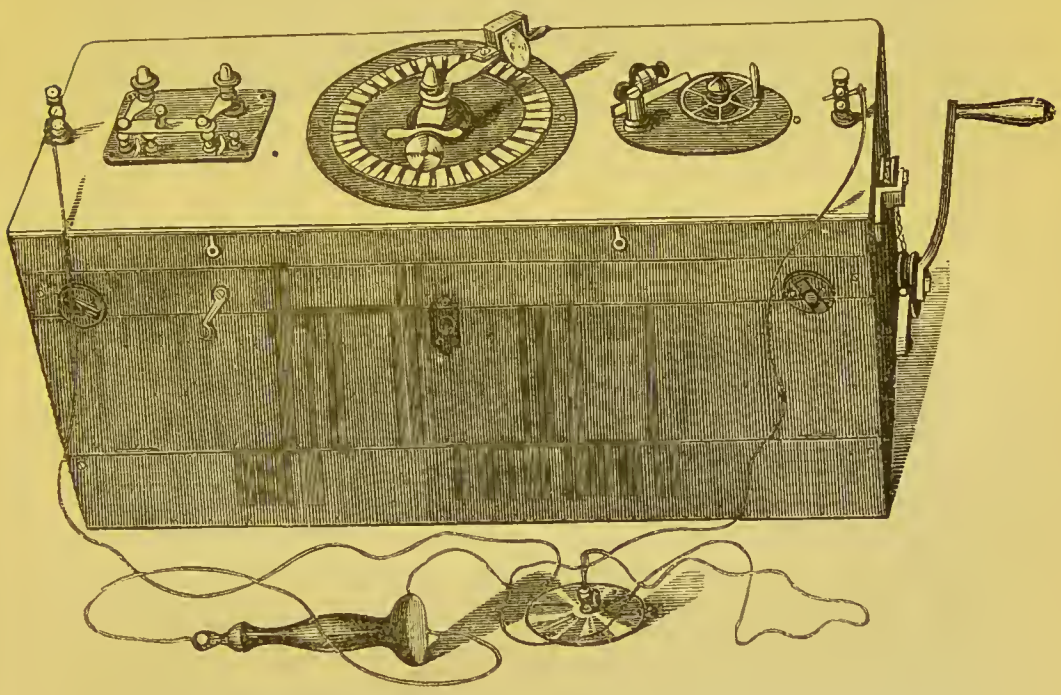
Remove the slide from the element board, and lift the latter out of the case, laying it upside down on a table; with a small screw-driver loosen, but do not take out, the screws which appear between each pair of elements; lift each pair of plates, holding it by the zinc, directly upwards, when it will disengage from a pin attached to the element board and fitting into it; the zinc and carbon plate can then

be separated by removing a screw with which they are transfixed. After the work of cleaning and amalgamation has been performed, the whole must be dried and carefully replaced exactly in the same order and position as before. Great delicacy is required in handling the carbons, as they are somewhat brittle; should one get broken at or near the end or right-hand side of the Battery, it is of little consequence, as the only result is loss of the power generated by the terminal cells, all the others being still available; but if the broken plate is in the beginning or centre, one should be taken from the end and substituted for it, pending the arrival of a new one from the maker.

With regard to this Battery, Dr Althaus says :— "This instrument is complete for all purposes of medical electricity; it has, however, yet to be shown whether there will be any real advantage to country practitioners in this arrangement, as it might be objected to it that where the practitioner has two instruments, one for galvanization and the other for Faradization, and one of them were to get out of order, he would not be entirely deprived of some source of electricity while the one instrument was being repaired; while, if anything happened to the combined arrangement, he would be altogether bereaved for a time. We do not say this by way of disparagement of the idea, which deserves all praise, but merely to suggest that there are two sides to the question."

The Americans have introduced a number of new Batteries, but none of them, so far as we know, involve any new principle or very different mode of construction; we borrow the drawing of Dr Jerome Kidder's Battery (Fig. 13), which appears to be well made, and to possess some advantages, from Dr Althaus's report. The plates are of carbon and zinc, excited by sulphuric acid, and the cells are raised by means of a winch and pulley outside the box; the

Fig. 13.



selector is circular, on Foveaux's principle, and is so arranged that the current may, at will, be interrupted or not, whilst altering the number of cells in action; a commutator of rather novel construction is added,

and a toothed wheel working against a tense spring for interrupting the current.

These Batteries are not common in England, nor is it likely they will ever come into serious competition with the many excellent instruments made on this side of the Atlantic.

A constant current Battery, the invention of Mr J. H. Sandy, Electrician to Guy's Hospital, has been shown to us by Messrs Evans, Lescher, and Evans, his agents, in which the supply of acid to the plates is furnished by means of pads ordinarily resting on a piece of india-rubber sponge, saturated with dilute sulphuric acid, but raised into contact with the elements by opening the lid of the case after the manner of Foveaux's Battery already described. We have been unable at present to obtain a woodcut of this instrument. It possesses a travelling selector, and appears to be well considered and well made; it lacks, however, a commutator for reversing the course of the current without shifting the electrodes.

As hinted earlier, we think it right briefly to allude to a correspondence still current in the pages of the 'Lancet' as to the value of a galvanometer or current measurer in electro-therapeutics, and the conclusion we have arrived at after very careful consideration of the subject, and consultation with every medical electrician with whom we have come in contact, is that the use of such an instrument is every way desirable, as lifting the medical use of

electricity out of the region of empiricism and rule of thumb into that of science. This is effected by enabling the practitioner accurately to measure the force of the current passing through his patient's body, and to regulate it according to the special requirements of each case.

In this view we are in accord with Dr. de Watteville, who, in his letter to the 'Lancet,' March 24th, 1877, writes as follows:—"A properly constructed galvanometer will show the current strength as a watch does the time. The well-known electrician, M. Gaiffe, has been long in the habit of supplying the buyers of his Batteries with an instrument of scientific precision that will measure, in British units, the current passing through the patient's body. My experience of it is most favourable. The principle of its construction is so simple that any instrument maker with sufficient electrical knowledge can construct one. A moderate number of turns of fine copper-wire are used, and the dial is graduated from simultaneous reduced readings on a tangent galvanometer. It is most convenient to have it graduated in 10,000ths of unit, and 1 to 150 is a sufficient number for all medical purposes. It is clear that with an instrument like this one can keep accurate records of cases, and prescribe accurately the dose of electricity. A current of 60, 100, or 150, for five or ten minutes conveys the same exact knowledge as so many grains so many times a day."

Here closes the series of constant current Batteries, from which we have endeavoured to omit none of established merit. The next Part is devoted to the description of Batteries constructed for the employment of the induced current.

PART II

ELECTRO-MAGNETIC MACHINES

The phenomena of Induction are the result of the circulation of an electric current through two helices or spirals of wire of different lengths and thicknesses, surrounding a core consisting of a rod of soft iron, or preferably, of a bundle of soft iron wires.

The currents afforded by the two wires are distinct, and that from the longer or secondary coil is much more intense than that yielded by the primary wire.

We do not propose to enter here into any explanation of the theory of this singular development of electric power, as it is a theme which belongs to the realm of Physics, and would be misplaced in a practical treatise like the present. The complete and exhaustive work of M. A. De la Rive will furnish those who seek it with every information on the subject, together with numberless researches and experiments concerning the nature of the force and the laws which govern it; our business is with its production and regulation for medical purposes.

The generating and sustaining agent of an induction machine is in all cases one or more pairs of elements, seldom exceeding two; the electro-motors may be of many kinds and various shapes, and acted upon by any substance capable of liberating electricity, which is transferred by conducting wires to the two coils of copper wire before referred to. Its action there is to instantaneously impart to the soft iron core a strong charge of magnetism, by virtue of which it attracts a hammer suspended by a light spring above or at the side of it, thus withdrawing the hammer from a previously existing metallic contact. The course of the current is in consequence intercepted, and the soft iron core loses its temporary magnetism as instantaneously as it acquired it, and ceases to attract the hammer, which under the influence of the spring regains its former position, restoring the contact and producing a very rapid recurrence of the same order of events as long as the circuit remains intact and the Battery continues to work.

The external and visible results of this action are a gentle humming noise, caused by the vibrations of the hammer, and the production of a succession of minute flashes of electric light; insulated cords connected with the extremities of the helices and carrying metallic plates produce on the body a disagreeable tingling sensation, which, if the power be sufficient, may increase till it becomes most acutely painful.

The above are the common characteristics of all Induction Machines. We will now proceed to a description of all the most ordinary and really useful types and of their mode of use, premising that their internal construction is far more complex and delicate than that of continuous current Batteries, and that if anything connected with the coils (we do not speak of the Battery, which is usually simple enough) gets out of gear, it is most unwise for any one to meddle with it except a mechanic thoroughly conversant with the work, who can readily and speedily discover and rectify what is amiss.

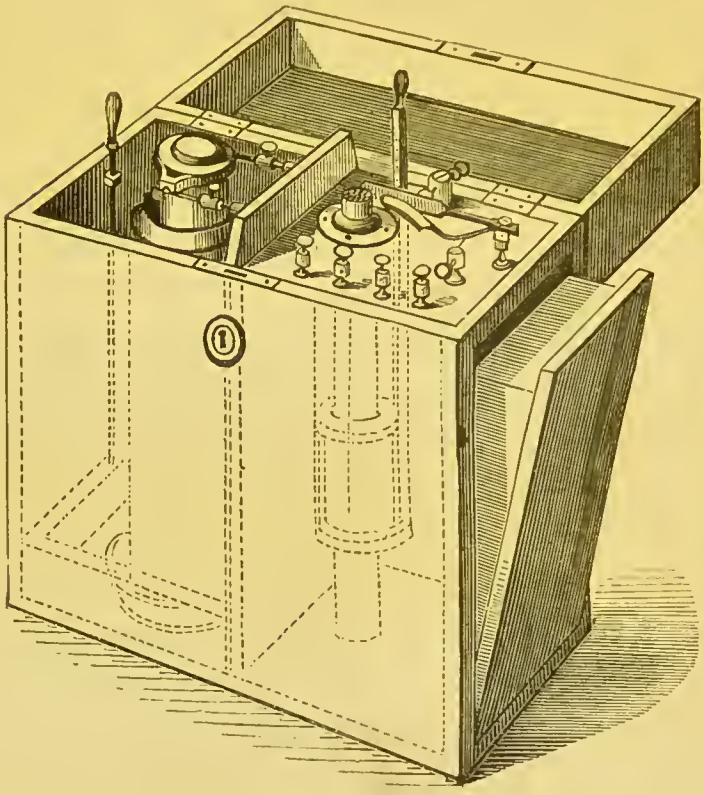
The Induction Batteries manufactured by Dr Stöhrer, of Dresden, are among those most widely known and generally approved. They are of two kinds, one being furnished with a single cell only, the other with two; they differ moreover, as will be explained below, in the arrangements for graduating and interrupting the current.

The single-cell Battery (Fig. 14) is divided into two parts, that on the left containing the elements and cell, and that on the right the coils, vibrating-hammer, the regulator, clamps for electrodes, and a drawer for rheophores and accessories.

The Battery, of which a separate illustration is given (Fig. 15), is composed of a pair of carbon and zinc elements, acted upon by diluted sulphuric acid, in the proportion of one in eight; the carbon is cylindrical in form, and hollowed nearly to the bottom for the reception of some fine sand, moistened

with a concentrated solution of chromic acid. It is surrounded by a hollow cylinder of amalgamated zinc with lateral slot, which, however, is insulated from it by small buttons of glass let into the carbon. The carbon cylinder is closed at the top with a glass stopper, and encircled with a metal clamp; wires

Fig. 14.



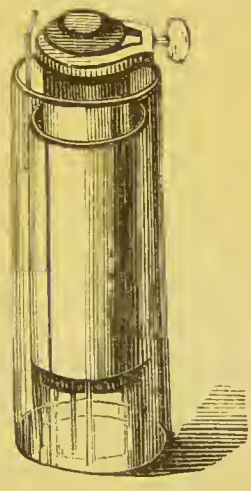
proceed both from the zinc and carbon elements to connect them with the coils.

The elements are received in a circular glass cell, resting upon a tray secured to a brass rod having a

handle whereby the cell can be raised or lowered so as to bring its fluid contents into, or remove them out of, contact with the elements, which remain suspended by the wire connexions; the brass rod may be fixed at any elevation by a binding-screw, the head of which appears outside the case. The cell is charged with dilute sulphuric acid to about one third of its capacity.

The induction apparatus, contained in the right-hand side of the box, consists of an inner and shorter

Fig. 15.



coil, surrounding a soft iron core, and composed of thick insulated (*i. e.* silk-covered) copper wire fixed immovably on a pedestal, and enveloped by a second coil, much longer and finer than itself, and capable of being drawn up quite over the first or primary coil, or pushed down so as to be almost entirely beneath it.

The interruptor consists of a square piece of iron, which is attached to a light spring, and vibrates to and fro, accordingly as the current is made or broken by the magnetization and subsequent demagnetization of the soft iron core; a regulating spring, acted upon by a platinum-pointed screw impinging on a small platinum disc on the hammer, increases or diminishes the relative pressure of the two, and modifies the rapidity of the interruptions and the intensity of the shocks; the tighter this screw presses against the spring, the less frequent will the interruptions become, and the more intense the shocks. The two clamps marked P connect the conducting wires with the primary, and those marked S with the secondary coil.

The management of this apparatus is exceedingly simple. The elements being fixed firmly in their places, and the nuts screwed home, the cell is one third filled with dilute sulphuric acid, as before stated, drawn up to a greater or less extent, and fixed by the external binding-screw, when the vibration of the hammer will at once commence, its rapidity being regulated by the set screw. Supposing the primary current to be in requisition, the wire conductors are inserted in their proper clamps, and their further ends screwed to appropriate rheophores.

The power of the current may be modified in three ways:

Firstly.—By the extent to which the elements are

subjected to the action of the acid ; when this is fresh, and the plates well amalgamated, a very slight immersion is sufficient.

Secondly.—By the tension of the spring as governed by the set screw.

Thirdly.—By inserting a short wire arch, which will be found in the drawer, into the holes of the two clamps of the secondary current, and drawing up the wooden handle, and with it the secondary coil, to its full extent. By a judicious use of these means or a combination of them a wide range of power is attainable.

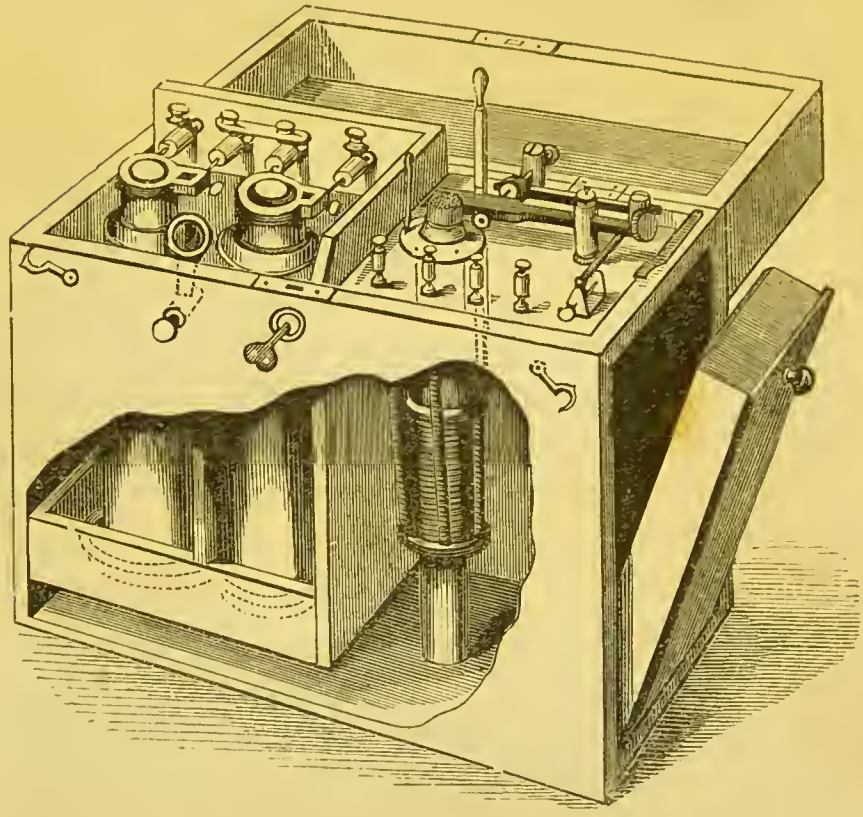
The secondary current is obtained by connecting the electrodes with the two clamps marked s, and is completely under the control of the wooden handle, which draws the secondary coil more or less over, and under the influence of, the primary coil; the current is weakest when the rod is pushed down, and strongest when it is drawn up, the intermediate degrees being marked by numbers on the rod.

In case the zinc becomes bare, and requires re-amalgamation, it can easily be removed from the Battery, and the operation performed as advised for the zinc plates of continuous current Batteries ; it is found that a little bisulphate of mercury mixed with the acid in the cell, aids greatly in preserving the amalgamation of the zinc. Both it and the acid must be renewed when the action of the Battery becomes

too feeble, and the sand inside the carbon should be moistened with a solution of chromic acid (ten or twelve drops) every second time of charging.

Stöhrer's double-cell induction machine (Fig. 16) is furnished, as its name implies, with two cells exactly similar to that described belonging to the

Fig. 16.



single-cell machine, and drawn Fig. 15; they are so arranged that one cell can be used separately, the two connected as two cells, or as one cell of double surface. The arrangement is as under:

1. To use one cell only: Insert only one of the long connecting brasses.
2. To use the two cells as two: Connect with the short brass connectors the carbon of one with the zinc of the other element.
3. To use the two cells as one of double surface: By means of the long brasses connect the carbon of one cell with the carbon of the other, and the zinc with the zinc.

Before affixing any of these connexions, tightly screw down the screws which hold the copper wires proceeding from the elements. The cells can be raised and lowered and fixed at any elevation, in the same manner as in the single-cell machine.

The arrangements for modifying the power of the current are the same in this Battery as in the former one, except that the primary coil is provided with a brass tube or damper sliding around it, and moved upwards or downwards by a brass handle visible at the side of the soft iron core; when this is quite drawn up, the current is greatly reduced, and, by inserting the copper arch in the two secondary clamps, and drawing up the wooden handle, may be brought to so small a minimum that it can be employed without pain or inconvenience to the head, face, or other sensitive part.

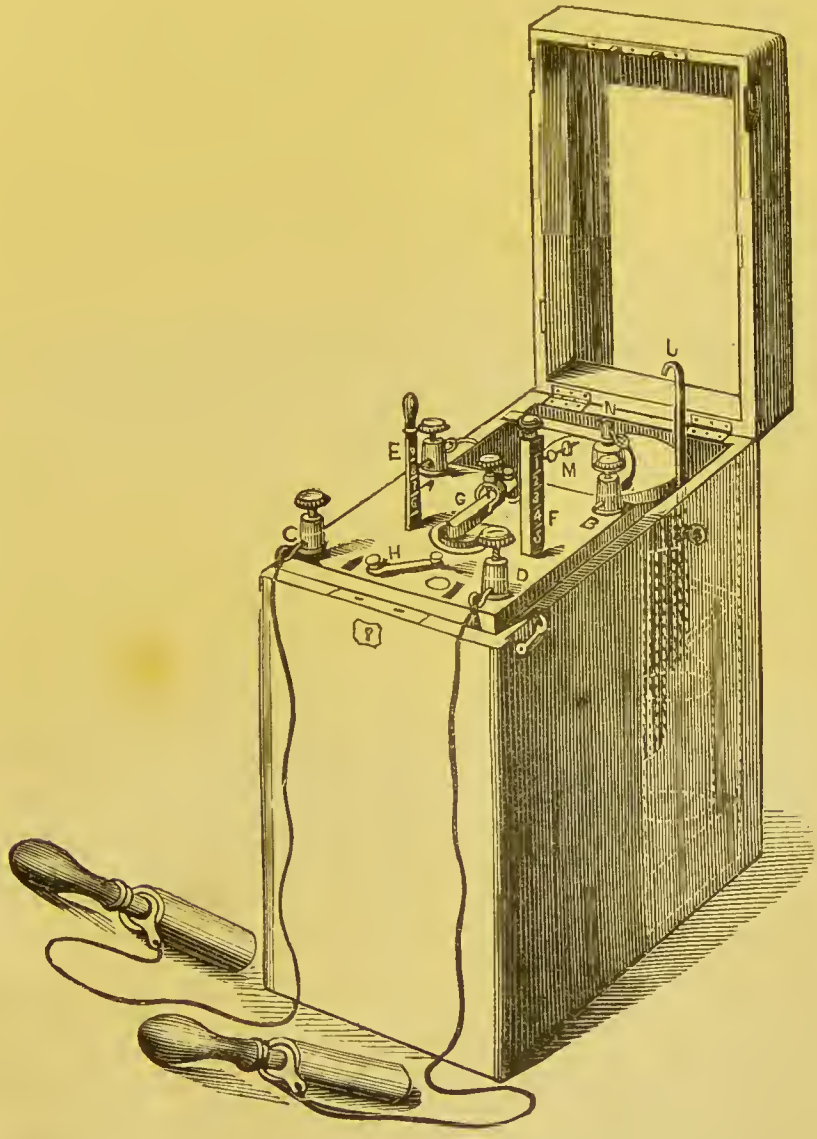
The great improvement in this Battery over the smaller one is the more delicate adjustment of the vibrating-hammer. In this instrument the platinum-

pointed screw is situated in the hammer, whilst the disc against which it impinges is moveably fixed to a spiral spring, the action of which is regulated by a screw from behind. In order to obtain very slow vibrations of the hammer, very little play must be allowed to the spring on which is the platinum-plate, and greater tension made on the spiral spring; to obtain rapid action, the screw must be turned against the platinum-plate so as to fix it, and no tension made on the spiral spring. In both forms of apparatus the plate against which the platinum-ended screw rests is capable of being turned round so as to expose a fresh point of contact when the old one has become oxidized by protracted exposure to the electric spark, or the oxide formed may be carefully removed with fine emery-paper.

Messrs Weiss and Son's Faradic apparatus (Fig. 17) is very similar in construction to Stöhrer's single-cell machine; the Battery, however, is placed at the back instead of at the side of the coils, and the motion of the hammer is vertical instead of horizontal. The Battery consists of one pair of zinc and carbon elements contained in a glass cell of convenient shape, which is capable of being raised or lowered and fixed at any height by a vertical rod with hooked top and binding-screw, the elements being meanwhile held suspended from the case by an iron cramp. Connexion is made between the Battery and the coils by two short insulated wires. A screw is placed above the contact-breaker or hammer to control the rapidity

of its action, and a commutator is added in the form of a knob attached to a short lever, by turning which

Fig. 17.



to the right or left on to two studs, marked respectively PRI (primary) and SEC (secondary) the primary current can be exchanged for the secondary or *vice*

versâ while the Battery is in action, and without changing the position of the cords. The internal arrangements of the coils and regulators are similar to those of Stöhrer's double-cell apparatus, a wooden rod governing the secondary, and a brass one the primary current. The Battery is excited by a solution of bichromate of potash mixed with a little sulphuric acid, and the following very concise directions for use are copied from the pamphlet issued by the makers.

Prepare a solution of bichromate of potash by dissolving $1\frac{3}{4}$ oz. of the salt in $16\frac{1}{2}$ oz. fluid measures of boiling water; when dissolved, add 1 oz. fluid measure of pure concentrated sulphuric acid; when cold, fill the Battery (Fig 17) (having previously unscrewed the cap) with the solution as high as indicated in the woodcut. Replace the Battery in the case, and draw up the tray containing it by the handle J, and fix it with the screw-nut L on the outside of the case. Fix one of the connectors in the terminal M of the Battery cover, and the terminal A of the coil; the other conductor is attached to the stem N, which carries the element, and terminal B of the coil. Attach the long conductors and sponge-holders to terminals C and D. When it is desired to employ the primary current only, turn the commutator H on to the brass stud next to PRI (primary) and draw up the rod E; the current being weakest when the rod, which is graduated from 1 to 9, is entirely drawn up.

For the secondary current, turn the commutator H on to the brass stud next to SEC, keep down rod E and draw up F more or less; this rod is also graduated from 1 to 9, and the current is weakest when it is nearly down. The beat of the contact-breaker G, which should be very regular and quick, is regulated by the screw on the top.

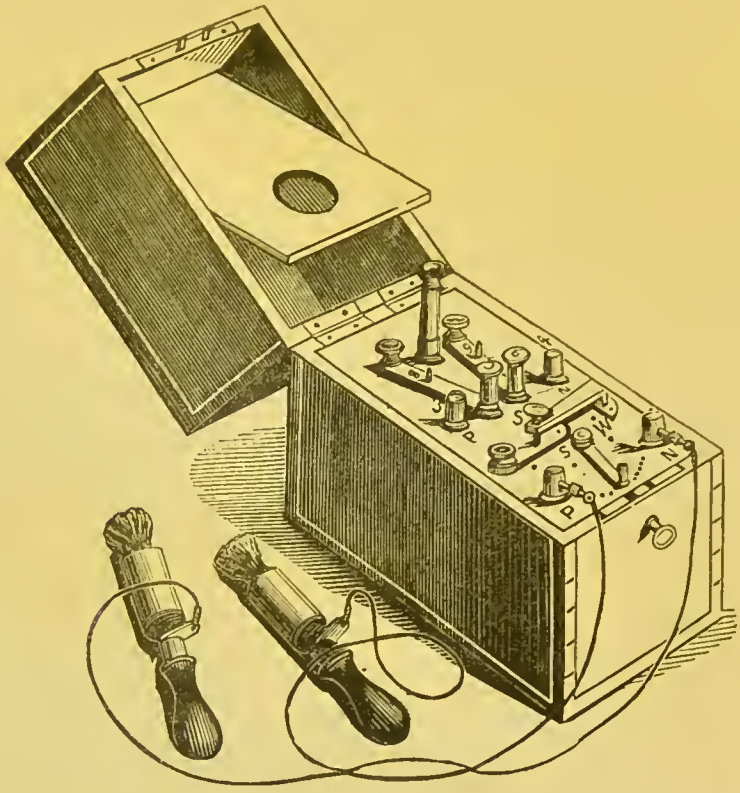
After some considerable wear the small platinum disc on the spring and the platinum point of the end of the screw of the contact-breaker may become oxidized and cause the action of the Battery to cease; the oxide must then be removed with fine emery-cloth. To prevent this as much as possible, it is best, when the fluid is fresh, only to draw it up sufficiently to keep the Battery going.

To extract the zinc element for amalgamation, remove the Battery cover, unscrew the top of the stem N, and draw the zinc plate down; the actual process of amalgamation has been already described, and after it has been performed the parts should be replaced as before.

Messrs Mayer and Meltzer have, at the suggestion, we believe, of Dr Morell Mackenzie, constructed a very portable and handy induction machine, contained in a small neat box (Fig. 18). This Battery, which is charged with the same solution as the one last described, is put into or out of action by raising or depressing a stem at the back of the box which is connected with the zinc plate of a Bunsen's pair so as to elevate it above the fluid, the carbon only

remaining immersed, or to lower it into it and set up galvanic action. The arrangement of the coils and contact-breaker is the same as in Weiss's Battery, as also the commutator for changing the currents, but the selector or graduator is on a different prin-

Fig. 18.



ciple : the variations of power are here controlled by a small lever moving over a number of brass studs, placed as a segment of a circle, and in contact with the coil at different points in its length. In the earlier machines of this pattern, from one of

which the above drawing was taken, there was a separate pair of studs for each current, and the top of the piston-rod was made to pass, when raised, through an opening in the lid, behind which were placed the electrodes and accessories; the later models, however, are much improved by being furnished with a commutator, and the piston is jointed and folds over when raised, the rheophores, &c., being placed at the side. The mode of charging the Battery is as follows :

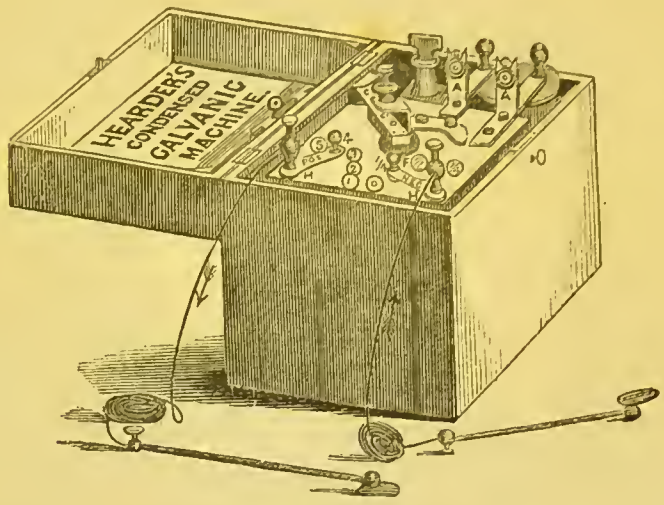
Unscrew the nuts at the end of the bars at the side of the piston, and turn the bars from under them; take out the back part of the Battery and turn the lid round until it comes off; fill the bottle about half full of the mixture of bichromate of potash and sulphuric acid, replace the cover and the Battery; turn back the brass arms, and screw the nuts tightly down upon them as before; insert the connecting wires in the clamps and push down the piston, when the Battery will at once act. The method of using the commutator has been explained, and the power of either current is increased by turning the long lever from right to left; the piston should be drawn up when the Battery is no longer required in action. When the action of the Battery becomes feeble throw away the old fluid, rinse the bottle, and pour in a fresh charge.

The manner of using the commutator and graduator as described above applies exactly to the induction portion of Mayer and Meltzer's large com-

pound Battery mentioned in the previous Part, where also instructions were given for placing the Battery in connexion with the coils.

Dr Hearder, of Plymouth, has brought forward a small Faradic machine (Fig. 19) which has the merit

Fig. 19.

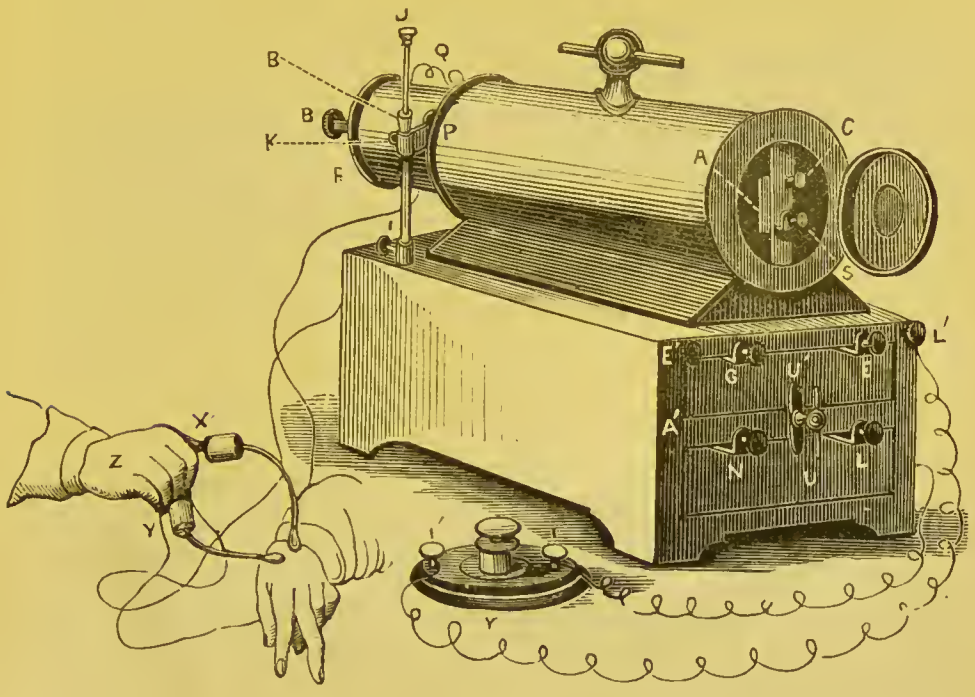


of being portable and cheap. The Battery consists of one pair of zinc and silver elements, excited by dilute sulphuric acid in the proportion of one in eight; a bottle inside the case holds the exact quantity of acid required for one charge. The Battery is connected with the coils by means of hooks, and there are two graduating levers, working over studs, the right-hand one of which increases the power four times more than the other for each additional stud; there are, however, no arrangements for the discrimination of the primary and secondary currents, the whole power being drawn

from the secondary wire at different points of its length.

Two very ingeniously constructed instruments, a larger and a smaller, have been devised by M. Duchenne, of Boulogne. These Batteries are very highly thought of by some medical men, notably by

Fig. 20.



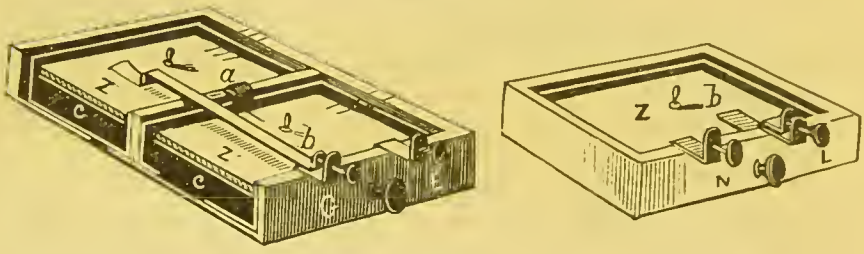
Dr Tibbits, who considers the large model as the very best form of apparatus known for Faradization ; probably it may be so in his hands, or in those of physicians who make a speciality of medical therapeutics, and devote much time and study to the subject, thereby acquiring sufficient experience to

render the practical manipulations and adjustments facile; they are, however, very delicate, and, the larger one especially, very complicated in their construction, and we doubt whether the ordinary practitioner would not find them rather unmanageable, and prefer to adopt a Battery of a simpler kind.

M. Duchenne's large Batteries have been constructed on various models, but the drawing given on p. 57 (Fig. 20) represents the most recent and perfect pattern.

The Battery, which is contained in the drawers U′ U in the base of the apparatus, is composed of three pairs of carbon and amalgmated zinc elements, the form and arrangement of which will be best understood by a reference to Fig. 21. The upper

Fig. 21.



drawer contains two compartments, with a single element in each; the lower drawer one element only, the connexions between them being made at G E N L. The carbon plates, C C, are immovably fixed at the bottom of the cells, and the exciting substance, bisulphate of mercury, is laid upon them and covered with pieces of moistened cloth; on these rest the

zinc plates, square in shape, and fitting nicely their respective receptacles.

The coils are contained in the brass cylinder, P A, and are of the usual description, viz. a longer and thinner helix of insulated copper wire, superposed upon a shorter and thicker coil of the same metal, and both surrounding a core of soft iron. The draw-tube or damper slides over the coils, enclosing them to a greater or less extent, and adjusting the strength of the current; its upper surface is graduated. A water moderator is also attached, which is a glass tube filled with distilled water, through which the current is made to pass, and which possesses facilities for altering by a slide the thickness, and consequent resistance, of the stratum of water lying between its two metal terminals.

The contact-breaker consists of a piece of soft iron, A, with platinized disc pressing against a platinum-pointed screw, S, and vibrating in the usual way between it and the soft iron core. A commutator of the coils (not seen in the engraving) is attached to the end of the Battery, and, in some instances, a commutator of the poles also, for reversing the course, as well as altering the character, of the current. A pedal rheotome, Y, is connected by insulated wires with the buttons, L L, and by its means very slow intermissions may be obtained; it is worked, as its name implies, by the foot, the pressure of which on the central knob completes the circuit, which is again interrupted by

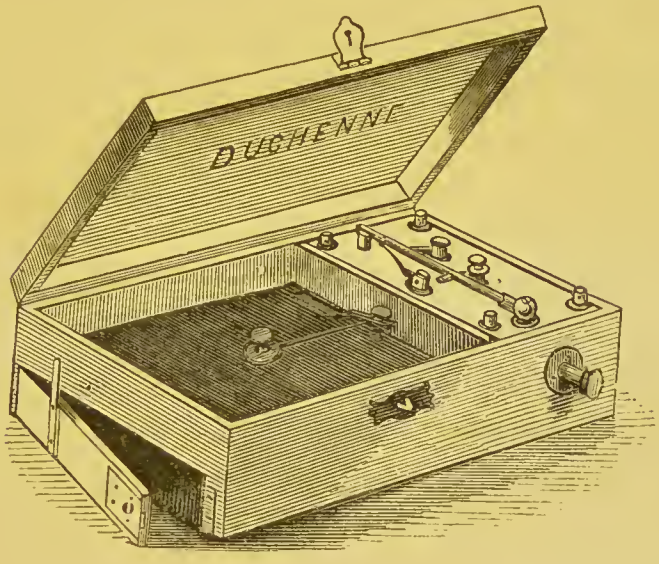
the removal of the foot, and consequent release of the spring.

To charge the Battery, the drawers (Fig. 22) containing the elements must be removed from the case, and the zinc plates and cloth diaphragms taken out; the carbons, which will then become visible, must be thoroughly saturated with water, and then carefully and smoothly covered with a layer of bisulphate of mercury about one tenth of an inch in thickness; the pieces of cloth are thoroughly wetted and laid on this powder, and finally the zinc plates on the cloth; the drawers are then replaced and secured by turning a handle between them, when the circuit is completed, and the Battery should act. The power of the current is graduated by drawing out the brass tube covering the coils, and the rod of the water moderator; and the rapidity of the intermission by the tension of the platinized screw on the vibrating hammer or by the rheotome. When the Battery is not in use the zinc plates should be taken out of the drawers and placed in a dry cupboard; the cloths will require damping daily, and the bisulphate must be renewed every three or four days.

We have not minutely described the connexions of the three cells *inter se*, and with the coils, as it would be difficult to make such an account intelligible without occupying too much space, and enough has already been said to enable the practitioner to work the instrument.

M. Duchenne's small Battery is contained in a flat oblong rosewood case, and is set in action by a single cell of similar construction to those employed in the larger Battery just described, and which fits into a cavity closed by a door, shown to the left of the case in the engraving; above it is a vacant space for the conducting wires and rheophores, and connexion is made between it and the coils by closing the door which opens to receive the elements, and screwing down a nut in the centre of the vacant space referred to. A spring with ivory

FIG. 22.



thumb-piece is placed in the same receptacle, and serves as a rheotome; by pressing this the current is interrupted, and the frequency of the intermissions can be governed at will.

The induction part of the machine consists, as

usual, of two insulated copper wire helices, superposed upon a soft iron core, and connected with a contact-breaker; the iron core, however, is in the form of a wide band, wound spirally into a helix, so as to expose a greater surface to the magnetizing influence of the electric current; this core is capable of being covered more or less by a metal draw-tube, so as to modify the strength of the currents.

The vibrating hammer is a long lever pressed by slight spring, and having on its right-hand side a screw which passes through it, tipped with platinum, and impinging against a platinized eccentric in connexion with the primary coil. By turning this eccentric, the amount of play allowed to the vibrating hammer, and consequently the frequency of the intermissions, can be modified. The hammer is attracted by the magnetization of a vertical iron bar in contact with the soft iron core in the centre of the coils. The electrodes are attached to the clamps at the four corners of the inductive part of the case, those at the right being the terminals of the primary, and those at the left of the secondary coil.

To charge the Battery, unscrew the nut in the centre of the left-hand partition, open the door at the end of the case, and take out the cell; lift off the zinc plate and cloth diaphragm, and carefully spread upon the carbon, which will then be uncovered, after having thoroughly saturated it with

water, a layer of bisulphate of mercury one tenth of an inch thick, and replace the wet cloth and the zinc plate as before, screwing down the central nut so as to be in contact with, but without pressing, the zinc. On closing the door and properly adjusting the trembler, the latter should immediately begin to vibrate with a velocity proportioned to the pressure upon it of the platinized eccentric; when the rheotome is used, the hammer should be pressed quite close against the magnetized iron bar.

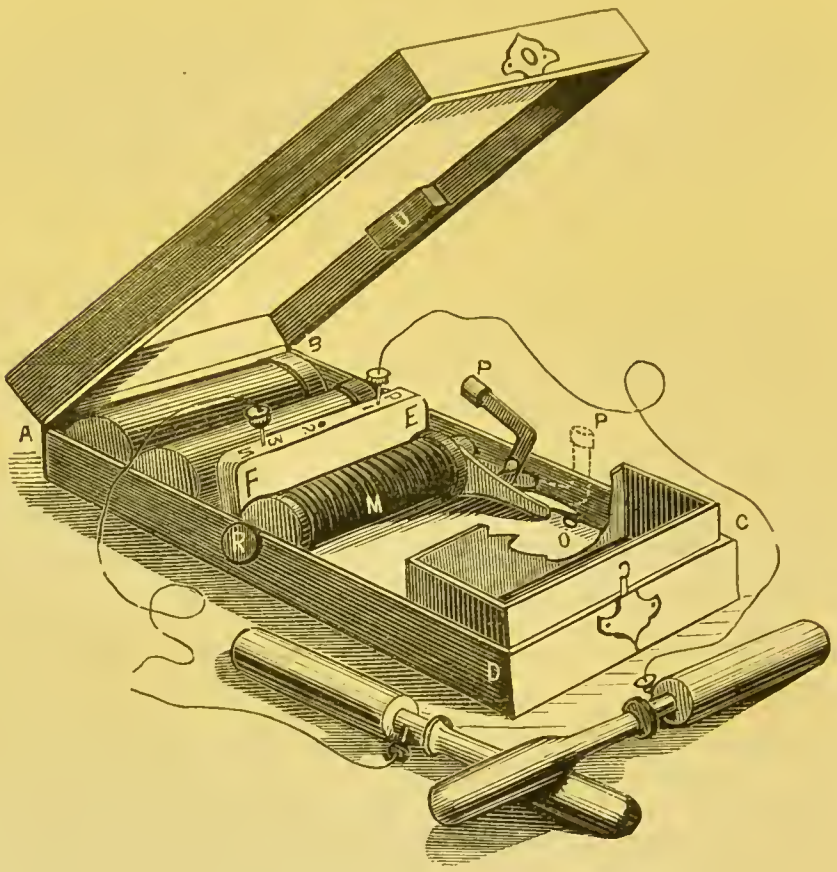
Dr Tibbits refers to this Battery in the following terms:—"The power of this small instrument is very considerable, regard being had to the small size of its coil. This is not only due to the excellent proportions of length and diameter of its wires and to good manufacture, but also, and chiefly, to the powerful magnetization of its band of soft iron rolled into a helix, which thus offers a considerable extent of surface."

We must qualify these laudatory remarks by saying that this Battery, like the larger one by the same inventor, is somewhat delicate in construction, and liable to get out of order; it is therefore better fitted to serve as an additional and accessory instrument than as the only one.

A very portable and neat little Battery (Fig. 23) is made by M. Gaiffe, of Paris. It fits into a case not larger than a small octavo volume, and may be described as under.

The coils, battery, and accessories are contained in a rectangular box, A B C D, which is divided into two parts by the raised partition, E F. The first

FIG. 23.



compartment contains the two chloride of silver cells of the Battery, placed between the sides of the box, and held there by two springs, which also serve as the connectors between the Battery and the coils.

The second compartment contains the coil, M,

which is a small edition of the usual induction coil; the button, R, is the extremity of a brass draw-tube, covering the soft iron core within the coil, and acting as a regulator for increasing or diminishing the intensity of the current.

The lever, P, regulates by its position the vibrating hammer, either approximating it close to the magnetized core, or withdrawing it beyond the range of its influence; between these two extremes any degree of tension of the spring of the trembler may be obtained, so as to govern the rapidity of the intermissions. At the vertical position, P, the hammer will vibrate, and in the horizontal position, P, the communication is broken and the Battery is at rest; it is in this position that the lever should be left after use. The case is so arranged that it cannot be closed while the lever is at any angle but the correct one for repose. By pressing with the finger on the ivory head of the lever it will be brought into contact with the button, O, and serving as a rheotome will enable shocks to be given at intervals regulated by the will of the operator.

On the upper surface of the partition, E F, are the extremities of the wires of the coil, Nos. 1, 2, and 3. Nos. 1 and 2 give the primary current; Nos. 2 and 3 the secondary current; and Nos. 1 and 3 the combined current. The free ends of the conducting wires are inserted into either pair of these holes as occasion may require, the further extremities carrying the rheophores, and the lever is turned

upwards until the necessary rapidity of intermissions is acquired.

Each cell is composed of a strip of zinc, and a strip of fused chloride of silver, contained in a vulcanite tube hermetically closed by a screw-top; the hooks of silver upon which the strips are fastened convey the current outside the vulcanite tube. A pad composed of six or eight strips of blotting-paper placed between the zinc and the chloride of silver retains the exciting fluid, which consists of water impregnated with five or six per cent. of chloride of sodium, or common salt; a rubber band binds the whole together.

To re-charge the Battery, unscrew the tops of the cells, take away the band and the pads, unhook the zinc and silver bars, and replace them, as well as the pads, by others, which can be obtained ready prepared from the vendors of the instrument; dip the strips in the exciting fluid to damp the paper, and screw the tops on again tightly. The newly-charged Battery only yields a feeble current, so that the circuit should be closed for about ten minutes previous to use, the lever standing at the position, P, when the current will be vigorously developed. The Battery, thus charged, should work continuously for eight hours.

This instrument is exceedingly portable, and would be very useful, were it not for the necessity it entails of constantly procuring fresh charges from the maker when the old ones are exhausted.

With M. Gaiffe's Battery closes the series of induction machines; some few others might have been mentioned, but they are chiefly of minor importance, and hardly suitable for medical use; we have therefore thought it better not to encumber the physician's choice with any but approved and really useful apparatus.

PART III

ACCESSORIES OF THE BATTERY

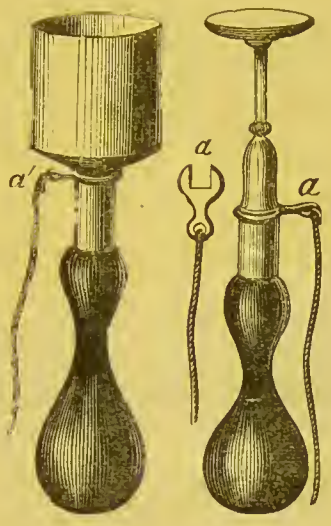
We now come to the accessories of the Battery, or the means whereby the electric current, produced and regulated as previously described, may be conveniently applied to the diseased part. They are comparatively few and simple, and consist of conducting wires, and rheophores of different shapes.

The conductors must be of copper wire or thread, about four feet long, and carefully insulated; they are usually made of several strands of copper thread, electro-plated, and covered with worsted, but occasionally of copper wire, coated with gutta percha, after the manner of underground telegraph wires; these are more durable than the former, but in our opinion the advantage thus gained is far more than compensated by loss of flexibility. They are secured to the Battery and handles either by a hook or fork enclosed between the two parts of the clamp or handle, or by a wire passing through a hole in the latter, and held fast by a binding-screw.

The most common and generally useful form of rheophores are the sponge-holder and disc (Fig. 24).

The sponge-holders are usually made with ebony handles, well rounded, on to which screw brass cups,

Fig. 24.



tinned or plated inside to resist the wet, and filled with sponges which have been moistened with saline

Fig. 25.

or acidulated water; the mode of attachment of the conducting wires may be easily seen from the

drawing. The brass cups should be short, so as to enable the operator to hold both conveniently with one hand, *without touching*, whilst electrizing any particular muscle, and at the same time to have the other free, to be employed in regulating the current or otherwise; the method of doing this is shown very clearly in Fig. 25.

The disc-rheophores are discs of metal of various sizes, fitting into the same handle by means of a

Figs. 26, 27.

brass stem; they should always be covered with wash-leather, and moistened with acidulated water. Where the surface to be electrized is small, the edge

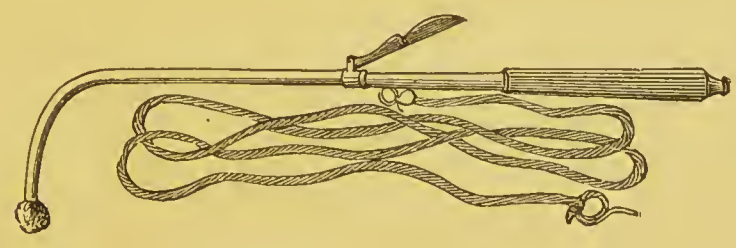
may be used very conveniently. Frequently carbon is substituted for metal in these rheophores, as in all Stöhrer's Batteries; these also should be covered.

Figs. 26, 27 represent olivary and conical metallic rheophores, also covered with wash-leather, and thoroughly moistened as before.

Fig. 28.

Fig. 28 represents a brush composed of wire threads, which expand to a greater or less circumference accordingly as the tube which binds them

Fig. 29.



together is pushed forward or drawn back; it is principally used for the spine.

Fig. 29 is Dr Morell Mackenzie's laryngeal rheophore, which consists of a handle carrying an insulated metallic stem, which terminates in a small spherical piece of sponge; a spring is attached,

whereby the contact may be made or broken at the will of the operator.

Dr Althaus's Serre-Fins Conductors for Electrolysis have recently come into extensive use; they consist of six steel gilt needles attached by rounded ends to as many small spring clips or "Serre Fins," all of which are in connexion, by means of insulated wires, with a common conductor also insulated, and secured to one pole of a Battery.

Numerous other forms of rheophore are made for special purposes, as for electrizing the rectum, urethra, uterus, and ear, and the number of them daily increases. The armamentorium of the practitioner would, however, be complete for all ordinary purposes with those already described, and special cases are usually best met by special appliances, information as to which can always be readily obtained.

*** Several of these drawings are copied from Dr. Tibbits.

PART IV

GALVANO-CAUSTIC BATTERIES AND APPARATUS

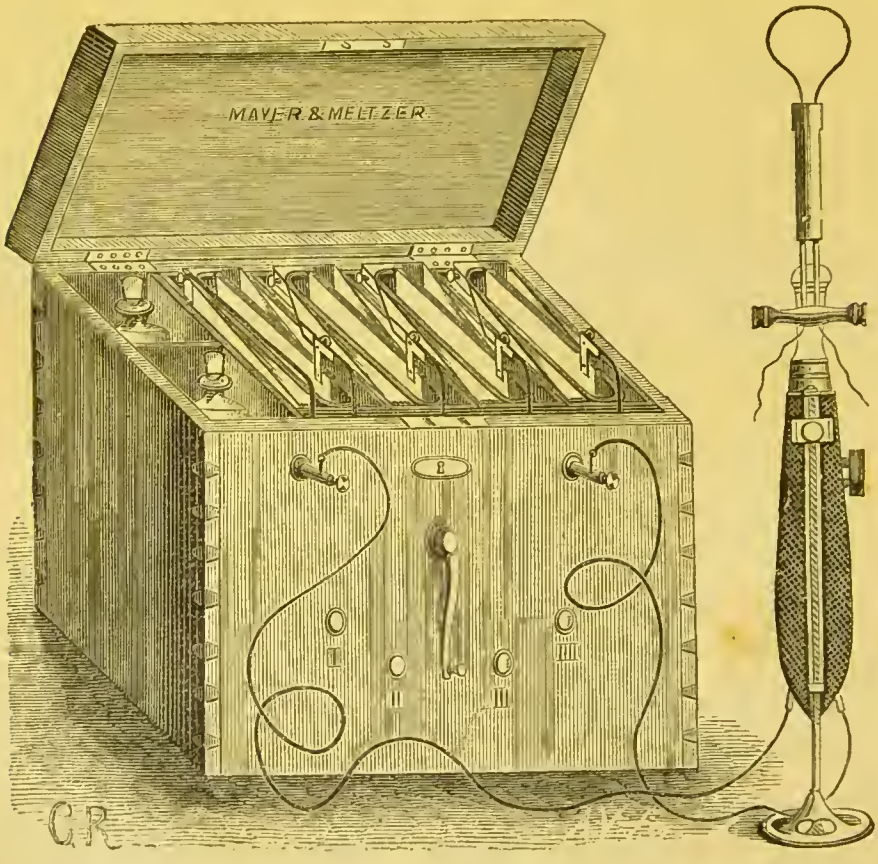
The earliest instruments for the application of the Galvanic Cautery come from France and Germany, and were the inventions of Grenet and Middeldorpff. The former of these Batteries we have not seen; it is worked by bellows, and, we are informed, is not very satisfactory.

Middeldorpff's Battery consists of four very large cells on Bunsen's principles; *i. e.* carbon and zinc elements excited by diluted sulphuric acid in the outer, and concentrated nitric acid in the inner or porous cell. The elements are connected by means of wires, with little cups placed on the top of a wooden rod in the centre of the case and filled with quicksilver. A number of discs of wood are provided, perforated with wires in different ways, which dip into the quicksilver contained in the small cups, and connect the cells together in any desired manner, either as four separate cells, or as one cell of four times the dimensions. One, two, or three cells can also be isolated and used in the same manner, and the whole are contained in a large square box. A case accompanies the Battery, containing a multitude of instruments adapted to the various purposes of

severing, piercing, or searing; each being provided with an interrupter for arresting the current until everything is in readiness for its instant employment.

We have had some considerable experience with this Battery, and have found it very troublesome in mounting and charging, and somewhat uncertain in its action; the acid, too, is apt to enter into ebullition, and the fumes given off are very disagreeable. Moreover, it is very expensive.

Fig. 30.



A far more convenient Battery is shown above

(Fig. 30). It consists of four zinc carbon pairs, with porous cells, charged with diluted sulphuric and strong nitric acid enclosed in a portable case, measuring fourteen inches long, nine inches wide, and seven deep, which contains also two bottles holding the acids required for charging; the conducting wires are fastened on the outside of a case, and there is a lever, by moving which on to either of four studs on the case, the number of cells in action can be regulated.

In all these Batteries, however, a very great evil lies in the use of concentrated acids, which necessitate the production of strong fumes, generally of nitrous acid. This has been obviated in a new Battery brought out lately by Messrs Mayer and Meltzer, which is very highly spoken of. It consists of three large vulcanite cells, into each of which dip ten pairs of large carbon and zinc plates connected with a bar, by means of which they can be lifted out of the fluid when not in use; the metal bars are connected, *inter se*, by insulated wires, which admit of as many cells as are needed being used independently. The cells are charged with a mixture composed of two ozs. of bichromate of potash dissolved in each pint of hot water, to which must be added, when cold, two ozs. of strong sulphuric acid. The mode of using the Battery is as follows:

To use one cell: Insert the hooks of the conducting cords in the first and second buttons from the left, the short cords being loose and uncon-

nected; tightly screw down the buttons, and push down the first row of elements, when one cell will be in action.

To use two cells: Insert the conducting wires at the first and third buttons; attach the short connector to the second button, and push down another row of elements.

To use all three cells: Connect both the short cords to the buttons on the left of them; fix the conducting wires to the first and last buttons, and push down the third cell, when the entire Battery will be in action. It will be seen that in this apparatus all noxious fumes are avoided.

Mr J. H. Sandy, Electrician to Guy's Hospital, has arranged a Battery for cautery purposes which is very highly spoken of; by a simple arrangement of a switch outside the Case a modification of either the Grove or Bunsen Battery admits of the current from four or more cells being instantly converted from a quantity to an intensity current or *vice versâ*:—This, though a very important qualification for a thoroughly efficient instrument, is ignored in most arrangements. The connections being outside the case are less liable to corrosion from the acid fumes, and provision is made for the use of one, two, three, or four cells at the will of the operator.

The conducting wires for the electric cautery should be of stout insulated copper wire, and not less than eight feet long, to admit of reaching any

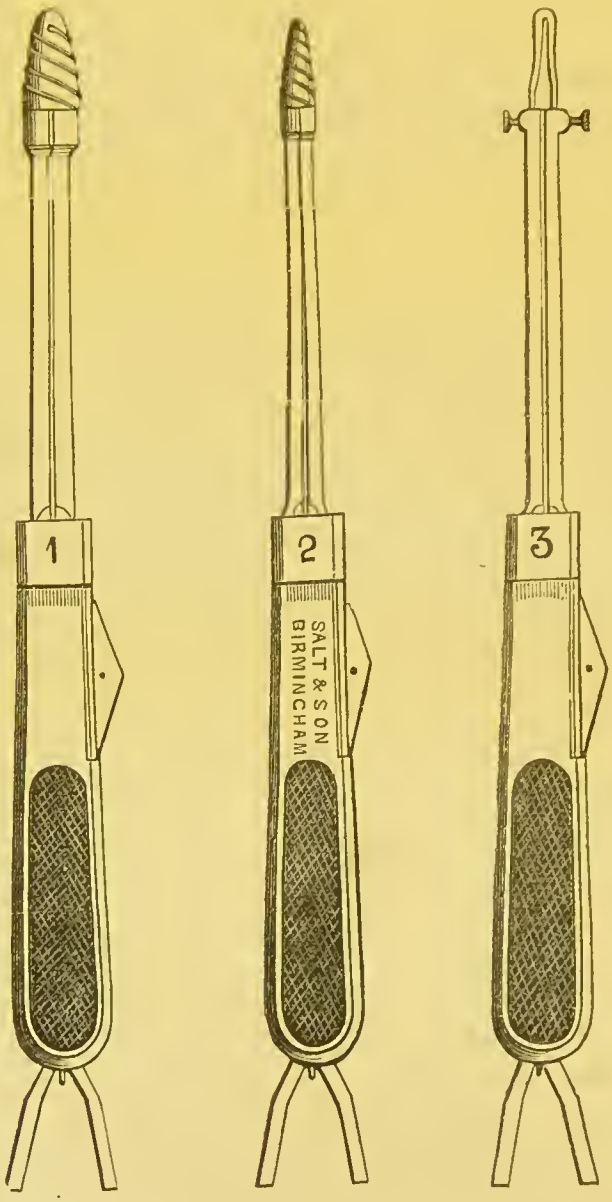
part of the patient's bed without bringing the Battery inconveniently near; the instruments used with them are the galvanic écraseur, and porcelain and platinum cauteries of different shapes and sizes.

The galvanic écraseur is shown at the side of the Battery (Fig. 30), and consists of a handle to which are attached the canulæ which guide the platinum wire, a screw with large milled head, having a traversing bar to which the free ends of the wire are attached, and a screw contact-breaker. The conducting wires having been inserted in the metal sockets of the wooden handle, and the platinum loop adjusted over the tongue or other part to be removed, contact is made by turning the little screw to the right until it impinges upon a small stud beneath it, and the screw of the écraseur very gently turned as the operation proceeds; it is always better to determine beforehand by heating the wire how many cells are needed, remembering that the longer the loop is the greater must the power be, and that too much heat is liable to produce bleeding, while too little would render the instrument powerless.

The other instruments in common use are porcelain cones of different sizes (Figs. 31, 32) surrounded with platinum wire wound round them spirally, and loops and wires of platinum, variously shaped, suitable for cauterizing tumours or operating within the bladder or other cavity. These are all provided with wooden handles, the wires leading to the points being carefully insulated from each other, and fur-

nished with a sliding current-breaker, by pressing which forward and backward, contact is either made or broken. Care must be taken with all these in-

Fig. 31. Fig. 32. Fig. 33.



struments not to perform the operation too rapidly, or the moist surfaces will frequently absorb the heat as rapidly as it is developed, and great disappointment result. In fact, as a general rule it is expedient to obtain the assistance of an expert, whose mind is free from anxiety for the patient, to take sole charge of the Battery and furnish such an amount of heat as the surgeon may deem necessary. Several surgical mechanists, ourselves among the number, are able and willing to undertake this duty.

The above being the last subject proposed at the outset to be dealt with, we venture, with confidence, to lay the result of our endeavours before the profession.

PRINTED BY J. E. ADLARD, BARTHOLOMEW CLOSE, E.C.

APPENDIX.

PRICES OF BATTERIES.

(Subject to fluctuations of the Market.)

	£	s.	d.
Becker-Muirhead Battery, 100 Cells . . .	25	0	0
Stöhrer's Constant Current Battery, 12 Cells . .	5	5	0
Ditto ditto 30 Cells . .	8	8	0
Ditto (for Hospital use) 40 Cells . .	10	10	0
Ditto Portable Constant Current Battery, 20 Cells .	8	8	0
Ditto ditto 30 Cells .	11	11	0
Salt and Son's New Portable Constant Current Battery, 20 Cells .	10	10	0
Ditto ditto 30 Cells .	12	12	0
Mottershead's Constant Current Battery, 20 Cells .	4	14	6
Ditto ditto 30 Cells .	8	8	0
Ditto ditto 50 Cells .	11	11	0
Leclanche's ditto manufactured by Telegraph Works Company, 40 Cells . .	10	0	0
Ditto ditto 50 Cells . .	11	0	0
Ditto ditto 60 Cells . .	13	0	0
Pulvermacher's Chain Bands . .	5/- to 63/-		
Ditto Batteries . £3 10/- to	6	6	0
Foveaux's (Weiss's) Constant Current Battery, 20 Cells .	6	0	0
Ditto ditto 25 Cells .	7	5	0
Ditto ditto 30 Cells .	8	10	0
Ditto ditto 50 Cells .	12	12	0
Mayer and Meltzer's Constant Current Battery, 20 Cells .	8	8	0
Ditto ditto Combined Battery . .	12	12	0
Stöhrer's Single-cell Induction Battery . .	4	10	0
Ditto Double-cell ,, ,, . .	6	10	0
Foveaux's (Weiss's) ,, ,, . .	4	14	6
Mackenzie's ,, ,, . .	4	4	0
Hearder's ,, ,, . 63/- 75/- and 90/-			
Duchenne's Large ,, ,, . .	12	12	0
Ditto (small size) ,, ,, . .	5	5	0
Gaiffe's ,, ,, . .	2	12	0
Galvano-Caustic Battery and Écraseur . .	10	10	0

A MANUAL

ON THE

MECHANICAL TREATMENT OF DEFORMITIES

AND

DEBILITIES OF THE LOWER EXTREMITIES.

Illustrated by Coloured Drawings, Woodcuts, and Litho-Photographs of the most improved mechanism employed.

DEDICATED BY PERMISSION TO DR. LITTLE,

Founder of the Royal Orthopædic Hospital,

By T. P. SALT, F.R.S.L.,

ANATOMICAL MECHANICIAN TO H.R.H. THE PRINCE OF WALES.

5s.

"General Knollys has laid Mr. Salt's book before H.R.H. the Prince of Wales, and is desired to convey to Mr. Salt the Prince's thanks and appreciation of so valuable a contribution to science."

"It is the work of an accomplished anatomical and orthopædic mechanician. Straightforward, honest books of this kind are very useful to the medical practitioner."—*Prov. Medical Journal.*

"The book is well worth perusal."—*Medical Times.*

"This is the work of an accomplished mechanician, which supplies a great deal of useful information on the mechanical treatment of deformities."—*British Medical Journal.*

"Mr. Salt's manual is a very good one."—*The Lancet.*

Also by the same Author.

A PRACTICAL TREATISE

ON THE VARIOUS

MECHANICAL CONTRIVANCES EMPLOYED FOR THE RELIEF OF HERNIA.

2s. 6d.

OPINIONS OF THE PRESS.

"Mr. Salt's book seems well calculated, in its way, for the removal of error and the diffusion of useful information in regard to the preservation of health, so far as the immediate subject is concerned."—*British Medical Journal.*

"The book is well illustrated, well penned, and well got up, and as a descriptive work on a class of instruments which are not sufficiently known, it will be a useful addition to the library of a medical man."—*Dublin Medical Press.*

"Mr. Salt describes very fairly his own truss, and some other instruments, belts, uterine supports, &c., and he evidently thoroughly understands his subject."—*Medical Times and Gazette.*

"In matter, style, printing, and paper the work is worthy of a place in any library."—*Birmingham Journal.*

SIXTH EDITION.

Prize Medal,
Dublin Exhibition,
1865.

Honorable Mention,
Paris Exhibition, 1867.

Grand Medal, Vienna,
1873.

Silver Medal,
Brussels, 1876.

SALT & SON'S

NEW

ILLUSTRATED CATALOGUE

OF

SURGICAL INSTRUMENTS,

ARTIFICIAL LIMBS,

TRUSSES, ABDOMINAL AND UMBILICAL BELTS,

APPARATUS FOR ALL KINDS OF BODILY DEFORMITY,

RESPIRATORS,

IMPROVED MEDICAL SYRINGES, LINT,

AND CUTLERY.

SALT & SON,

Patentees,

BY APPOINTMENT, CUTLERS TO HER MAJESTY THE QUEEN.

ANATOMICAL MECHANICIANS TO H.R.H. THE PRINCE OF WALES.

AUTHORS OF TREATISES ON DEFORMITY AND RUPTURE.

SURGICAL INSTRUMENT MAKERS TO THE HOSPITALS.

21, BULL STREET, BIRMINGHAM.

EXHIBITIONS

London, 1851.

"Mr Salt's collection shows that some of our Provincial Instrument Manufacturers are treading somewhat severely upon the heels of the London Manufacturers."—*Medical Times.*

"If we regard goodness of Workmanship and variety of appliance, Mr Salt will not be greatly distanced."—*Daily News.*

"What Mr Salt exhibits is exquisite of its kind."—*Birmingham Journal.*

Paris, 1855.

"Mr Salt's display of Surgical Instruments is very superior."—*Birmingham Herald.*

Dublin, 1865.

"Mr Salt, of Birmingham, has a splendid collection of Trusses, which display admirable workmanship."—*Irish Times.*

Paris, 1867.

"In regard not only to improved principles of construction, but thorough excellence, the articles of Messrs. Salt and Son merit the highest commendation."—*Midland Counties Herald.*

"Mr Salt's inventions must almost be looked upon as a service rendered to the State."—*Birmingham Journal.*

Prize Medal,
Dublin,
1865.

Hon. Mention,
Paris,
1867.

Grand Medal,
Vienna,
1873.

Silver Medal, Brussels,
1876.